LOWLAND RAINFOREST ON FLOODPLAIN - PROFILE

Scientific name: *Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion*
Conservation status in NSW: Endangered Ecological Community

Description

Lowland Rainforest on Floodplain is a rainforest community which now occurs only as small remnants in scattered localities on the NSW north coast, with less than 1000ha in total thought to remain. Larger stands of the community typically have a dense canopy, which blocks most light from reaching the ground, creating cool, moist conditions within. Lowland Rainforest on Floodplain supports a rich diversity of plants and animals. Typical tree species in the community include figs (*Ficus macrophylla*, *F. obliqua* and *F. watkinsiana*), palms (*Archontophoenix cunninghamiana* and *Livistona australis*), Silky Oak (*Grevillea robusta*), Black Bean (*Castanospermum australe*) and Brush Cherry (*Syzygium australe*). Animals present include fruit-eating rainforest pigeons, Noisy Pitta, Brush-turkey, pademelons, flying foxes, the Land Mullet skink and rainforest snails.

Location and habitat

Distribution

The NSW north coast

Habitat and ecology

This community occurs on fertile soils in lowland river valleys.

Regional information

This species is found in the Hunter/Central Rivers and Northern Rivers management authority regions.

References

NSW NPWS (2002). Threatened Species of the Upper North Coast of NSW: Flora. NSW NPWS, Coffs Harbour, NSW.

"NSW Scientific Committee (1999) Lowland rainforest on floodplain in the NSW North Coast Bioregion - Endangered ecological community determination - final. DEC (NSW), Sydney."

SUB-TROPICAL COASTAL FLOODPLAIN FOREST - PROFILE

Scientific name: *Sub-tropical Coastal Floodplain Forest of the NSW North Coast bioregion*
Conservation status in NSW: Endangered Ecological Community

Description

This sub-tropical forest occurs on the coastal floodplains of the North Coast of NSW. It has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality.

While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. siderophloia* (grey ironbark), *Corymbia intermedia* (pink bloodwood) and, north of the Macleay floodplain, *Lophostemon suaveolens* (swamp turpentine).

Other trees may be scattered throughout at low abundance or locally common at few sites, particularly where there is an influence from lithic substrates upslope. These include *Eucalyptus moluccana* (grey box), *E. propinqua* (grey gum), *E. seeana* (narrow-leaved red gum), *Angophora subvelutina* (broad-leaved apple), *E. robusta* (swamp mahogany), *Eucalyptus resinifera* subsp. *hemilampra* (red mahogany), *E. acmenoides* (white mahogany), *Angophora woodsiana, A. paludosa* and rainforest trees such as *Ficus* spp. (figs) and *Cupaniopsis* spp. (tuckeroos).

A layer of small trees may be present, including *Allocasuarina torulosa* (forest oak), *Alphitonia excelsa* (red ash), *Glochidion ferdinandi* (cheese tree), *Callistemon* spp., *Melaleuca* spp. and *Casuarina glauca* (swamp oak).

Scattered shrubs include *Breynia oblongifolia, Acacia concurrens, Commersonia* spp., and *Hibiscus* spp. Occasional vines include *Eustrephus latifolius, Parsonsia straminea* and *Geitonoplesium cymosum*. The groundcover is composed of abundant forbs, scramblers and grasses including *Imperata cylindrica, Themeda australis, Vernonia cinerea, Dianella caerulea, Pratia purpurascens, Cheilanthes sieberi* and *Dichondra repens*.

The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.

Location and habitat

Distribution

Subtropical Coastal Floodplain Forest is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, but may occur elsewhere in this bioregion. Major examples once occurred on the floodplains of the Tweed, Richmond, Clarence, Macleay, Hastings and Manning Rivers, although smaller floodplains would have also supported considerable areas of this community.

The extent of the Subtropical Coastal Floodplain Forest prior to European settlement has not been mapped across its entire range. However, the remaining area of Subtropical Coastal Floodplain Forest is likely to be considerably smaller and is likely to represent much less than 30% of its original range. There are less than 350 ha of native floodplain vegetation on the Tweed lowlands.

Small areas of Subtropical Coastal Floodplain Forest are contained within existing conservation reserves, including Stotts Island, Ukerebagh and Limeburners Creek Nature Reserves and

Bundjalung and Myall Lakes National Parks. These are unevenly distributed throughout the range and unlikely to represent the full diversity of the community.

Habitat and ecology

- Occupies central or marginal parts of floodplains and sandy flats, including Pleistocene back-barrier flats; habitats where flooding is periodic and soils are rich in silt and sand, sometimes humic, and show little influence of saline ground water.
- Associated with clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains.
- Generally occurs below 50 m, but may occur on localised river flats up to 250 m elevation.
- The structure of the community may vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees. Typically these forests and woodlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water.

Regional information

This species is found in the Hunter/Central Rivers and Northern Rivers catchment management authority regions.

Reference

"NSW Scientific Committee (2004) Subtropical coastal floodplain forest of the NSW North Coast bioregion - Endangered ecological community determination - final. DEC (NSW), Sydney."

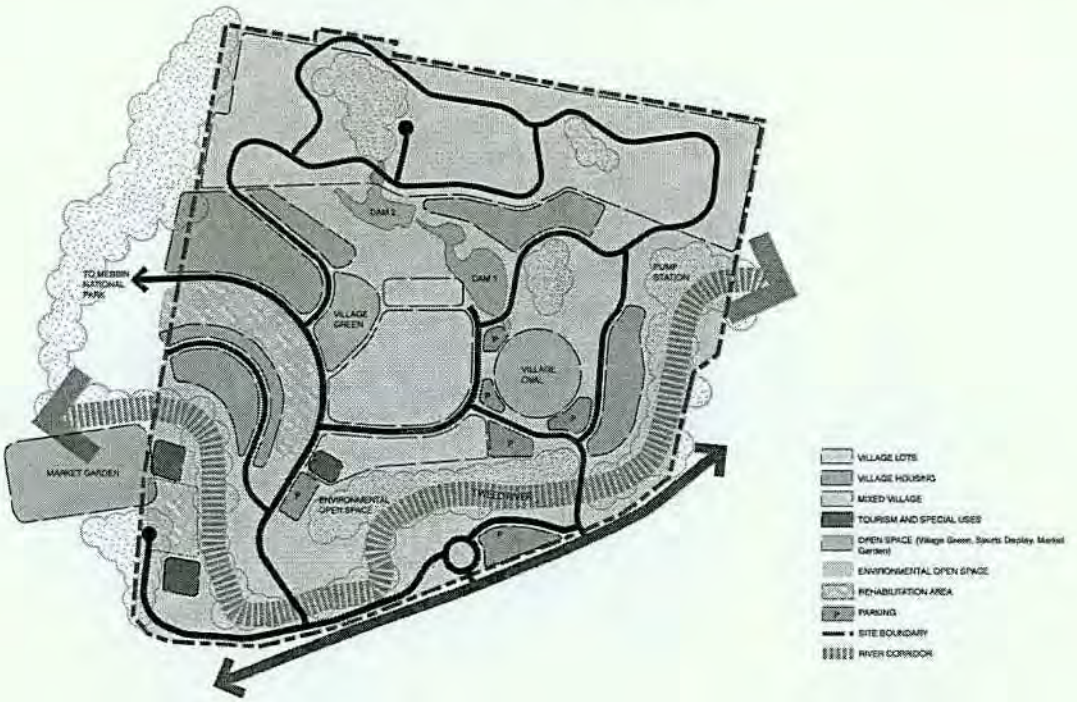
APPENDIX C

Rehabilitation Concept Plan

REHABILITATION CONCEPT PLAN

The proposed Nightcap Village plan of development makes provision for the retention and rehabilitation of native vegetation on the site for a variety of nature conservation and landscape amenity purposes. In this respect the Nightcap Village Concept Plan, presented below, identifies key areas where vegetation retention and rehabilitation strategies are to be implemented within the site boundaries.

Nightcap Village Concept Plan



CONCEPT PLAN A

Vegetation Retention and Rehabilitation Areas

As part of the Nightcap Village development substantial areas of existing native vegetation will be retained and will be incorporated into the layout of development. These areas of vegetation to be retained possess significant ecological and landscape amenity values and include:

- existing riparian vegetation lining the bed and banks of the Tweed River, which traverses the southern sector of the site, that provide habitat for a diversity of native wildlife species including significant fauna species such as the Koala; and
- several pockets of native forest vegetation that are scattered throughout the site, including areas that provide habitat for significant flora species such as the Green-leaved rose walnut.

The retention of these areas of native vegetation provides an opportunity to rehabilitate these areas through the removal of declared weed species and other significant exotic species and the planting out of appropriate endemic native plant species thereby improving and enhancing the ecological and landscape amenity values of these vegetation communities.

Re-vegetation Areas

The proposed plan of development incorporates the revegetation of Rehabilitation Areas as illustrated in the attached Concept Plan. The vegetation within these areas is currently in a highly disturbed state and is characterised by grassland with scattered trees.

Under the proposed plan of development, these areas would be rehabilitated, involving:

- the removal of declared weed species and other significant introduced plant species; and
- the planting out of suitable, locally endemic flora species to restore vegetation communities that occur naturally elsewhere within the site and those described within the Tweed Vegetation Management Strategy, 2004[15].

These rehabilitation works would improve the ecological values of degraded areas within the site and would enhance their visual and scenic amenity.

Special consideration is required for any rehabilitation within the site that is to be undertaken within the recommended bushfire setbacks as discussed in the Bushfire Management Plan prepared for the site by Cardno. In this respect, the species should be selected that are appropriate in terms of their potential fuel load capacity.

Species Selection

The rehabilitation/revegetation strategies to be followed within the Rehabilitation Areas within the buffers and landscape stands (i.e. retained clumps of native vegetation and riparian vegetation associated with the Tweed River) would involve the removal of any existing infestation of weed species, removal of deposited miscellaneous waste, and the planting out of suitable, locally endemic flora species to restore vegetation communities that would have naturally occurred in the subject areas. In this respect the rehabilitation programs would be designed to establish, via active planting and encouragement of natural regeneration, a complex of vegetation communities derived from the following vegetation types of the Tweed Vegetation Management Strategy 2004[20]:

Vegetation Type 206: Flooded Gum Open Forest which is described as follows.

> *...a tall open to open, wet sclerophyll forest on moderate to fertile soils, often in sheltered moist locations such as valley floors along watercourses. Flooded Gum* (Eucalyptus grandis) *is generally the clear dominant species but this species often occurs with one or two associates. Typically associated canopy species, which occur as co-dominants include Brush Box* (Lophostemon confertus) *and Tallowwood* (E. microcorys). *Flooded Gum open forest frequently occurs with a rainforest understorey, which may in time replace this type. This species is known to require a major disturbance event such as fire to regenerate, forming as small even-aged stands. Species that occur as locally or sub-dominant species include Sydney Blue Gum* (E. saligna), *Turpentine* (Syncarpia glomulifera), *White Mahogany* (E. acmenoides), *Pink Bloodwood* (Corymbia intermedia), *Hoop Pine* (Araucaria cunninghamii) *and Silky Oak* (Grevillea robusta).

Vegetation Type 102: Sub-tropical/Warm Temperate Rainforest which is described as follows.

[20] Kingston, M.B., Turnbull, J.W. and P.W. Hall (2004) *Tweed Vegetation Management Strategy 2004 Volume 3 of 3 – Appendices*. A report prepared for Tweed Shire Council by Ecograph: Ecological and Geographical Information Systems Consultants – Limpinwood, NSW

Sub-tropical Rainforests are the most complex sub-formations within NSW, occurring in warm sites with a high annual rainfall. Typically comprising two or three vegetation strata and forming an uneven canopy with strangling figs, palms, plank buttresses, large epiphytes and woody vines (Floyd 1990). These forests occur at low altitudes on fertile lowland krasnozem soils near sea level or on basaltic soils up to 600m.

Main canopy species of this component include White Booyong (Argyrodendron trifoliolatum), *Red Carabeen* (Geissois benthamii), *Marara* (Pseudoweinmannia lachnocarpa), *Pepperberry Ash* (Cryptocarya obovata), *Cudgerie* (Flindersia schottiana), *Yellowwood* (F. xanthoxyla), *Red Cedar* (Toona ciliata), *Tulipwood* (Harpullia pendula), *Blue Quandong* (Elaeocarpus angustifolius), *Hard Quandong* (E. obovatus), *Myrtle Ebony* (Diospyros pentamera), *Black Bean* (Castanospermum australe), *Red Bean* (Dysoxylum muelleri), *Purple Cherry* (Syzygium crebrinerve), *Bangalow Palm* (Archontophoenix cunninghamiana), *Cabbage Palm* (Livistona australis), *Black Booyong* (*Argyrodendron actinophyllum*), *Giant Stinging Tree* (Dendrocnide excelsa), *Yellow Carabeen* (Sloanea woollsii), *Rosewood* (Dysoxylum fraserianum), *Giant Water Gum* (Szygium francisii), *Soft Corkwood* (Caldcluvia paniculosa), *Pigeonberry Ash* (Cryptocarya erythroxylon), *Prickly Ash* (Orites excelsa), *Doughwood* (Melicope octandra) *and Red Apple* (Acmena ingens).

Warm Temperate Rainforests contain fewer species than sub-tropical and dry rainforests and forms a more uniform canopy with typically two vegetation strata (Floyd 1990). They occur in cool, moist areas and tend to lack epiphytes, orchids and tropical features such as stranglers, plank buttresses, woody vines and palms (Floyd 1990). The occurrences of this suballiance within Tweed Shire are among the most floristically diverse in NSW due to their geographical location and mixed nature (Floyd 1990). They occur on less fertile metasediments, basaltically enriched metasediments and on rhyolite with basaltic enrichment on alluvial flats. Specific occurrences are Hogan's Scrub Wildlife Refuge (containing a State record for different tree species present (Floyd 1990)), lower Couchy Creek and Christies Creek in Mooball State Forest.

Main canopy species of this component include Jackwood (Cryptocarya glaucescens), *Sassafras* (Doryphora sassafras), *Mango Bark* (Canarium australasicum), *Yellow Carabeen* (Sloanea woollsii), *Durobby/Coolamon* (Syzygium moorei), *Coachwood* (*Ceratopetalum apetalum*), *Callicoma* (Callicoma serratifolia), *Water Gum* (Tristaniopsis laurina), *Bennet's Ash* (Flindersia bennettiana) *and some sub-tropical species.*

In addition, the rehabilitation of vegetation communities may also include native species that have been recorded on the site during field surveys, such as:

- **Canopy species** such as Flooded gum, Brush box, Silky oak, Tallowwood, Pink Bloodwood, Grey Ironbark and Hoop Pine;

- **Midstorey species** such as Tree heath, Lightwood, Coffee bush, Poison peach, Black bean, Hard quandong, White cedar, Native tamarind, Maiden's wattle, Rice flower, Steelwood, Native guava, *Seringia arborescens*, Sweet pittosporum, Tree heath, Broad-leaf palm lily, Rose myrtle, Tuckeroo, Guioa, Pointed-leaf hovea, Sandfly zieria, Brown tuckeroo, Red ash, Cockspur thorn, Sandpaper fig, *Gossia hillii*, Macaranga, Soft corkwood, Foambark, Laceflower tree, Green wattle, Jackwood, White bottlebrush, Scrub turpentine, *Persoonia conjuncta*, Red kennedy pea, Bennett's ash, Silky myrtle, Lilly pilly, Rusty helicia, Kangaroo Vine and Red kamala.

- **Ground layer species** such as Austral sarsparilla, Snake vine, *Lomandra longifolia,* Bracken, *Lomandra hystrix,* Rough maidenhair fern, *Blechnum* sp., Barbed wire grass, *Gahnia aspera* and Soft bracken.

Species selection and plant placement will be undertaken in an appropriate manner taking into consideration the habitat requirements of the each particular plant species.

Vegetation of Conservation Significance

The Flooded gum (*Eucalyptus grandis*) open forest community on the site (refer Section 4.2.2 and Figure 3 of the Ecological Assessment prepared by Cardno), in which the *Endangered* flora species Green-leaved rose walnut (*Endiandra muelleri* subsp. *bracteata*) pursuant to the *Threatened Species Conservation Act 1995* was recorded, is to be retained as illustrated in the Concept Plan. The opportunity for the rehabilitation of this community via the removal of exotic weed species and planting out of endemic native species would assist in the conservation and protection of this significant flora species within the site.

The rehabilitation of degraded areas within the site would create additional habitat resources for native fauna species. The opportunity for rehabilitation of the buffer associated with the Tweed River will enhance and expand the existing riparian corridor that traverses this waterway, which would likely increase habitat utilisation by native fauna. In this respect, the inclusion of known Koala food trees within the revegetation of this riparian vegetation community would provide additional habitat resources for the Koala which is listed as *Vulnerable* pursuant to the *Threatened Species Conservation Act*.

It is also relevant to note that the rehabilitation and expansion in width of the riparian corridor associated with the Tweed River will increase the current extent of vegetation assemblages within the site which are considered to be broadly analogous to two Endangered Ecological Communities listed under the *Threatened Species Conservation Act*, namely the:

- *Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion*; and
- *Sub-tropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion*.

It is considered that any such increase would more than adequately compensate for losses to existing vegetation assemblages that are broadly analogous to these communities, which would occur as a consequence of the proposed plan of development.

Re-vegetation / Rehabilitation Strategies

The particular manner in which the revegetation works would be carried out will be detailed within a Vegetation Management Plan ("VMP") that would be prepared and submitted to Council in support of any subsequent applications for approval of the physical works associated with the proposed plan of development. The VMP would include detail in respect of the:

- the specific objectives of the revegetation works;
- details of the methods to be used in the revegetation works (i.e. weed control and removal, planting strategies, species etc.);
- monitoring responsibilities; and
- maintenance schedule and corrective actions.

The VMP would provide detail regarding the revegetation of the Rehabilitation Areas, the rehabilitation of the retained landscape stands (i.e. the retained clumps of native vegetation and riparian vegetation associated with the Tweed River) and other landscaping works within the site that would form part of the proposed plan of development. As previously discussed, it is recommended that the restoration of vegetation communities utilises native species that have been recorded on the site and those that are listed within the vegetation types as described in the Tweed Vegetation Management Strategy 2004.

Weed Control

As part of the development of the site existing weed infestations would be controlled. In this respect a Weed Management Plan ("WMP") would be prepared as a component part of any site based VMP. The WMP would detail:

1. the current extent and distribution within the site of declared plant species pursuant to the *Noxious Weeds Act 1993*;
2. suitable methods of chemically and mechanically controlling these existing infestations;
3. suitable methods of disposing of removed weed material;
4. appropriate strategies for ensuring additional declared plant species are not introduced to the site during construction activities (e.g. hosing down of construction machinery prior to entry to the site, ensuring the use of clean fill etc.);
5. an appropriate post-control monitoring program; and
6. a task schedule outlining the timing of relevant management actions and the roles and responsibilities of relevant parties.

At present, the site supports several declared weeds pursuant to the *Noxious Weeds Act*. These weeds are listed the table below.

Species Name	Common Name	Control Category *
Baccharis halimifolia	Groundsel bush	W2
Ageratina adenophora	Crofton weed	W3
Lantana camara	Lantana	W3
Ageratina riparia	Mistflower	W3
Cinnamomum camphora	Camphor laurel	W4 (d)

Within the Far North Coast Weeds district the following Control Categories apply.

W1 = The presence of these weeds on land (or on/in water) must be reported to the Local Control Authority, and the weed must be fully and continuously suppressed and destroyed

W2 = The weed must be fully and continuously suppressed and destroyed

W3 = The weed must be prevented from spreading and its numbers and distribution reduced

W4 = The action specified in the declaration must be taken in respect of these weeds

W4(b) = The weed must not be sold, propagated or knowing distributed and any existing weed must be prevented from flowering and fruiting

W4(d) = The weed must not be sold, propagated or knowingly distributed and the weed must be fully and continuously suppressed and destroyed if it is:

- *three (3) metres in height or less; or*
- *within half a kilometre of remnant urban bushland, as defined by SEPP 19, and is not deemed by a local control authority as having historical or heritage significance; or*
- *is over three metres in height and not included in a Management Plan approved by the local control authority.*
- *The W4(d) declaration applies to Copmanhurst, Kyogle, Richmond Valley and Lismore Council areas and that part of Ballina Council area south of the Bruxner Highway*

W4(f) = Shall not be sold, propagated or knowingly distributed. Occupiers must implement any biological control or other program directed by the local control authority must be implemented.

W4(g) = The weed must not be sold, propagated or knowingly distributed.

Every effort would be made to ensure that the proposed development does not result in the introduction to or further spread within the site of declared pest plants, pursuant to the *Noxious Weeds Act*.

Any declared pest plants identified as having been introduced to the site as a consequence of the proposed development would be controlled using appropriate means of chemical or mechanical weed control.

6. NIGHTCAP VILLAGE FLOOD STUDY

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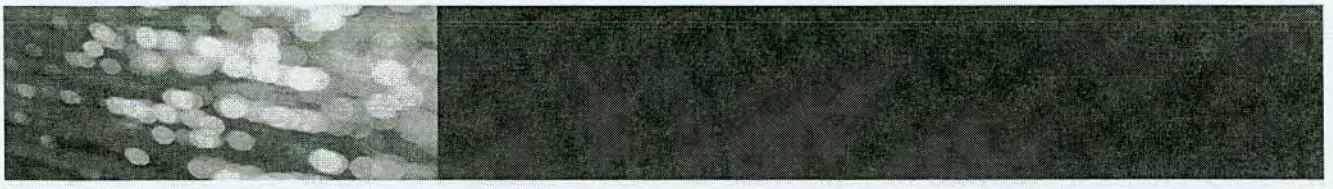

Nightcap Urban Village

Flood Study

29 June 2006
Job No. 3500/53

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Document Control

Version	Date	Author		Reviewer	
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1	17 March 2006	Sid Duty	SBD	Martin Giles	MG
2	2 May 2006	Sid Duty	SBD	Martin Giles	MG
3	29 June 2006	Sid Duty	SBD	Martin Giles	MG

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NIGHTCAP URBAN VILLAGE
FLOOD STUDY

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APPENDIX A Rainfall and Runoff Calculations (Summary)
APPENDIX B HEC-RAS Cross Sections

EXECUTIVE SUMMARY

The proposed development, on Kyogle Road, Kunghur, is bordered on its southern edge by the Tweed River. The site is undulating in its northern limits, but includes areas of level ground adjacent to the watercourse. This report describes the detailed flood study undertaken to predict the flood levels applicable to the site.

Peak flow rates for the Tweed River through the site were estimated using standard methods for New South Wales (see Section 2) after having determined the catchment area. Cross sections were obtained from a detailed topographical survey of the site, and input into the HEC-RAS hydraulic modelling software.

The resulting flood levels vary according to local topography, and as the river level falls naturally through the site. These derived levels are displayed graphically on aerial photography and on site development plans, the latter indicating that the risk to residents and property is minimal providing that sensible design measures are employed.

Previous reports have shown that proposed development on some of the lower lying areas of the site could have been subject to flooding in the most extreme events. The Concept Plan has been amended in the light of these findings, reshaping or removing development zones out of the flood inundation area. The Village Housing zone in the south west of the site is an exception to this; in this case, levels will be raised using fill material, sufficient to preclude the risk of inundation.

1. INTRODUCTION

It is proposed to develop a site on Kyogle Road in the Kunghur area of north-eastern New South Wales to create a residential village. The site falls within the jurisdiction of Tweed Shire Council, and as the site is adjacent to the Tweed River, a flood study is required to determine the flood levels applicable to the site. This report details Cardno's advice in this regard.

As can be seen from Figure 1, the site is bounded by Kyogle Road to the south, and the southern extents lies within meanders of the Tweed River. The site, of over 45 hectares in area, is undulating in the north, but much of the southern area lies on level ground close to the river.

The site is currently characterised by pockets of woodland among open grassland. Development proposals include residential lots of varying density, and accompanying sports, recreation, hotel and commercial areas. Most of the proposed development is already positioned some distance from the river, a riparian zone having been identified which also forms a buffer between the site and Kyogle Road.

The Tweed River, as it enters the site, has a contributing catchment of over 3,726 hectares, originating in the hilly country several kilometres to the southwest. It flows from the west and leaves the site in the east, and falls approximately eight metres as it travels 1750 metres through the site.

For the analysis, the 100-year event was considered in accordance with the requirements of Tweed Shire Council Development Control Plan (DCP) 16.

2. HYDROLOGY

Peak discharges were calculated using the Rational Method, in accordance with *Australian Rainfall and Runoff* (Institute of Engineers Australia, 1987), after having established the catchment area (shown in Figure 2). Design rainfall intensities were accessed for the site using the AUSIFD software, and are reproduced below.

Table 1 Rainfall Intensity for Kunghur, NSW

Duration	Average Recurrence Interval			
	1 year (mm/hr)	10 year (mm/hr)	20 year (mm/hr)	100 year (mm/hr)
10 mins	91	160	181	231
30 mins	54	97	110	142
60 mins	36.9	67	77	99

The time of concentration (i.e. the time taken for rainfall to travel to the site under examination) is critical in assessing runoff from the catchment. As the site is rural in nature, the method recommended for Eastern New South Wales in *Australian Rainfall and Runoff* (Volume 1, Section 5.4.1) has been employed.

Once the time of concentration has been derived (a function of catchment area) a series of modifications to the rational method are followed to account for regional differences, which results in an estimated design flood magnitude. In this case, the 100-year flow is estimated to be 426 m^3/s. Full details of the calculations are given in Appendix A.

3. HYDRAULIC MODEL

3.1 HEC-RAS Model Setup

HEC-RAS is an industry-standard one-dimensional hydraulic model used to perform hydraulic calculations for constructed and natural waterways. A HEC-RAS model was created using 21 cross-sections derived from a detailed survey, which crossed the channel and continued on to higher ground. Where these sections did not extend far enough (where they meet the road at the southern edge of the site, for example) they were extended using available contour data. The locations of the cross sections are shown in Figure 3.

Manning's n values will vary between the channel, the immediate vicinity of its banks, and the wider floodplain. Manning's numbers have been estimated to be 0.025 for the channel, 0.15 for the thick vegetation at the top of the banks, and 0.05 for the wider grassed floodplains.

In previous reports, development zones were found to infringe on the derived flood inundation area. The affected zones have now been reshaped or removed to preclude the possibility of flooding. An exception to this process occurs for the Village Housing zone in the southwest of the site. Ground levels in this area will be raised using fill material, and this has been modelled by the use of ineffective flow areas in Sections 17 to 19 (positioned where the cross section meets the development zone and set at a theoretical height sufficient to preclude overtopping).

3.2 Flood Inundation Levels

The model provides maximum water levels at each section for the 100-year event. The flood extent is shown graphically in Figure 3, showing the area of inundation over aerial photography, and in Figure 4, showing the inundation in relation to the Structure Plan. By comparing water levels with ground levels across the proposed lots, it can be concluded that the lots are free from flooding.

Table 2 Flood Inundation Levels

Section	100yr level (m AHD)	Section	100yr level (m AHD)
22	82.47	**11**	77.15
21	80.17	**10**	77.11
20	79.29	**8**	75.57
19	79.20	**7**	75.55
18	79.34	**6**	74.44
17	78.56	**5**	74.43
16	78.54	**4**	74.13
15	77.69	**3**	74.24
14	77.49	**2**	72.86
13	77.62	**1**	72.23
12	77.44		

4. CONCLUSION

It is proposed to develop an area at Kunghur, north of the Tweed River, for mixed use development. The threat of inundation to property in the 100-year design rainfall event has been assessed.

A HEC-RAS model of the site was set up using Rational Method calculations adapted for eastern New South Wales, based on a topographical survey of the area and 21 surveyed cross-sections.

Previous reports have shown that proposed development on some of the lower lying areas of the site could have been subject to flooding in the most extreme events. The Concept Plan has been amended in the light of these findings, and this updated report concludes that the proposed development is free from flood inundation.

FIGURES

Figure 1 **Locality Plan**

Figure 2 **Catchment Area**

Figure 3 **100-Year Flood Extent & Cross Section Locations**

Figure 4 **100-Year Flood Extent Relative to Structure Plan**

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Peter Van Lieshout

CAD FILE: I:\3500-53\ACAD\Flood Study\Figure 1 - Locality Plan.dwg
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FIGURE 1
LOCALITY PLAN

Project No.: 3500/53

PRINT DATE: 20 March, 2006 - 4:07pm

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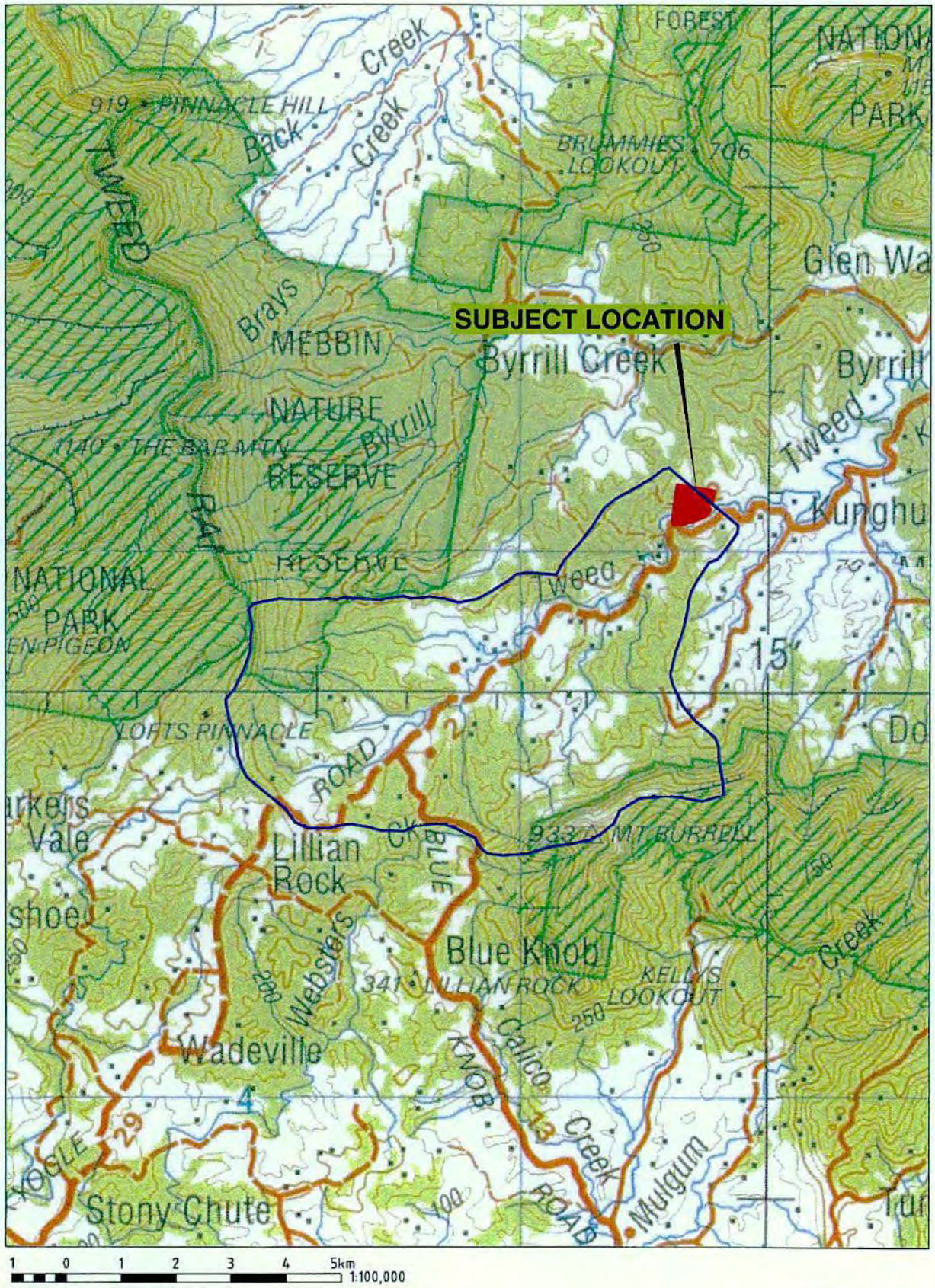

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FIGURE 2
CATCHMENT AREA

Rev: Orig. Date: 10 February 2006

Project No.: 3500/53

Peter Van Lieshout

CAD FILE: I:\3500-53\ACAD\Flood Study\Figure 2 - Catchment Area.dwg
XREFs: xr-Cadastre_study_area MGA94, xr-NSW Topo Maps

PRINT DATE: 20 March, 2006 - 4:05pm

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FIGURE 3
100 YEAR FLOOD EXTENT & CROSS SECTION LOCATIONS

Rev: A Date: 29 June 2006

Peter Van Lieshout

CAD FILE I:\3500-53\ACAD\Flood Study\Figure 3A - 100 Year Flood Extent.dwg
XREF's: xr-Aerial Ortho GASCO, xr-Contours GASCO

Project No.: 3500/53

PRINT DATE 27 July, 2006 - 3:10pm

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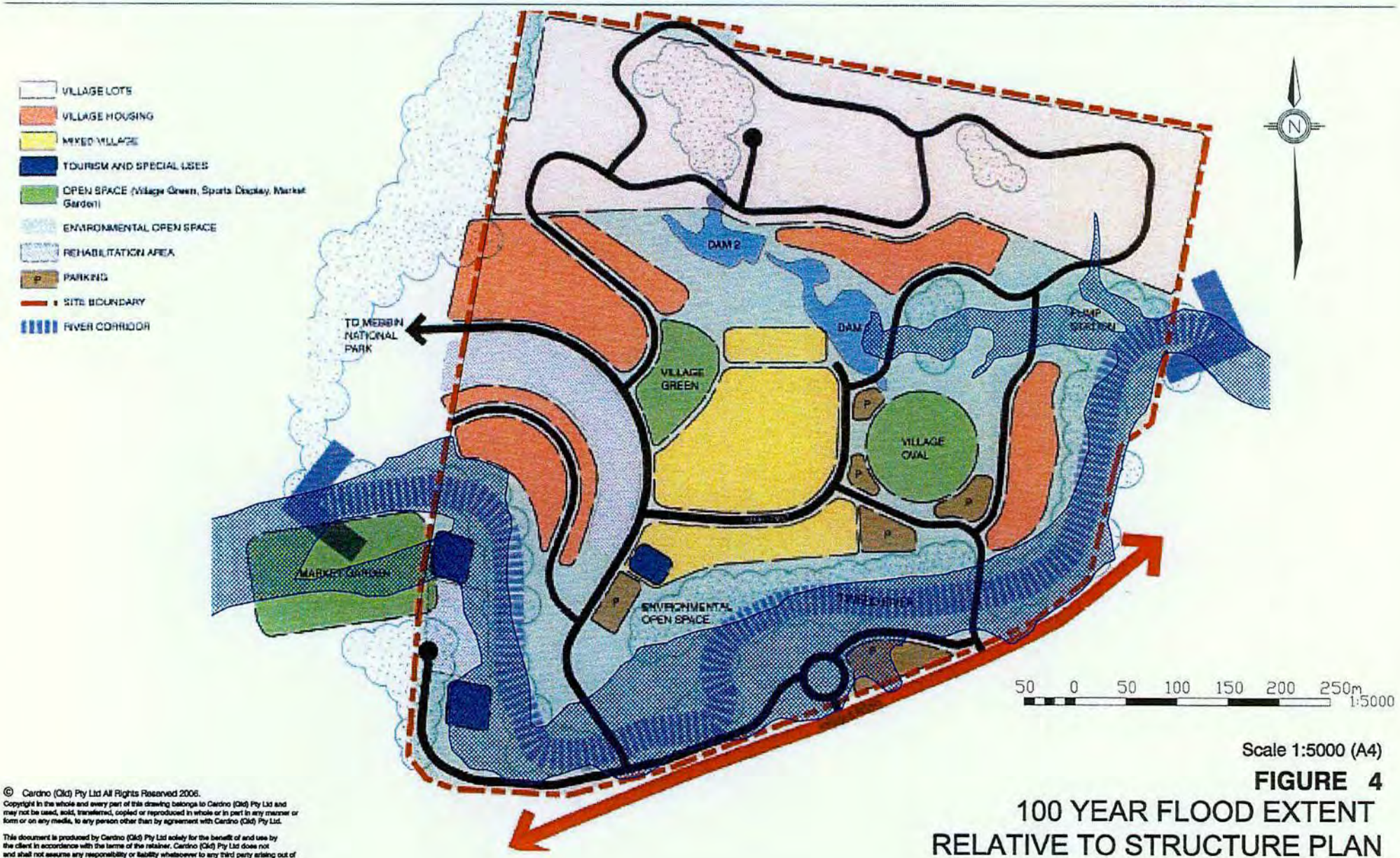

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FIGURE 4

100 YEAR FLOOD EXTENT RELATIVE TO STRUCTURE PLAN

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Rev: 1 Date: 29 June 2006

Peter Van Lieshout

Project No.: 3500/53

APPENDIX A

Rainfall and Runoff Calculations (Summary)

From Australian Rainfall and Runoff, Volume Two, Section 5.4.1a

i. determine critical duration

Catchment area = 37.26 km^2

t_c = 0.76 . A . 0.38 = approx 3 hrs, or 180 mins

ii. design rainfall intensity

from AusIFD = 58mm

iii. runoff coefficient C_{10}

from fig. 5.1 = 60% (or east of line) or 0.6

iv. frequency factor, FF_y

FF_{100} from table 5.1 = 2.45 – [(0.588 . $I_{12.50}$) / $I_{12.2}$]

= 2.45 – [(0.588 .25.4) / 118] = 1.184

$C_y = C_{10}$ x FF_y = 0.6 x 1.184 = 0.71

v. design flood magnitude

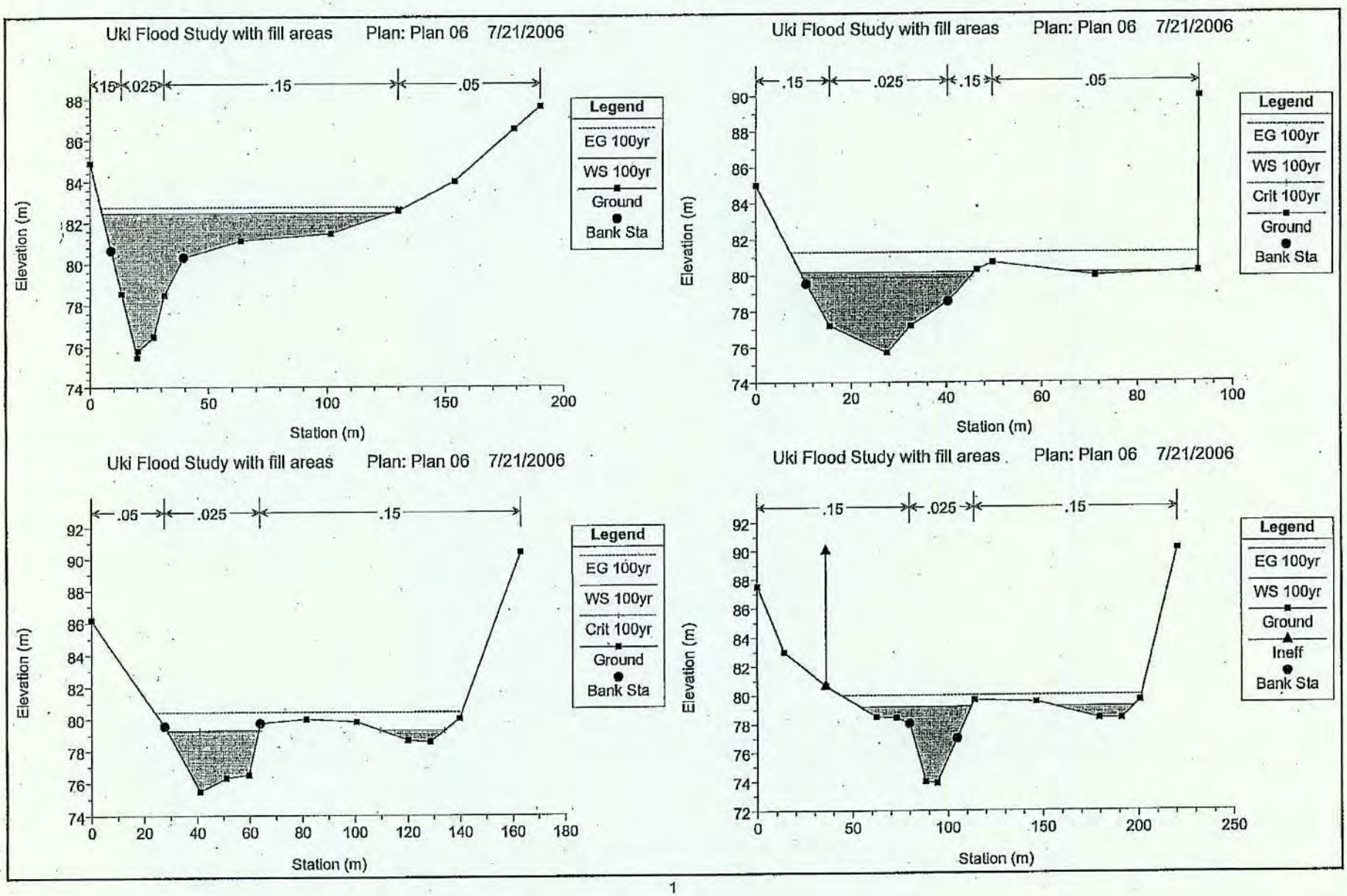
Eqn. 5.1 = 0.278 . C_y . $I_{tc,y}$. A

= 0.278 . 0.71 . 58 . 37.26

= 427 m^3/s

APPENDIX B

HEC-RAS Cross Sections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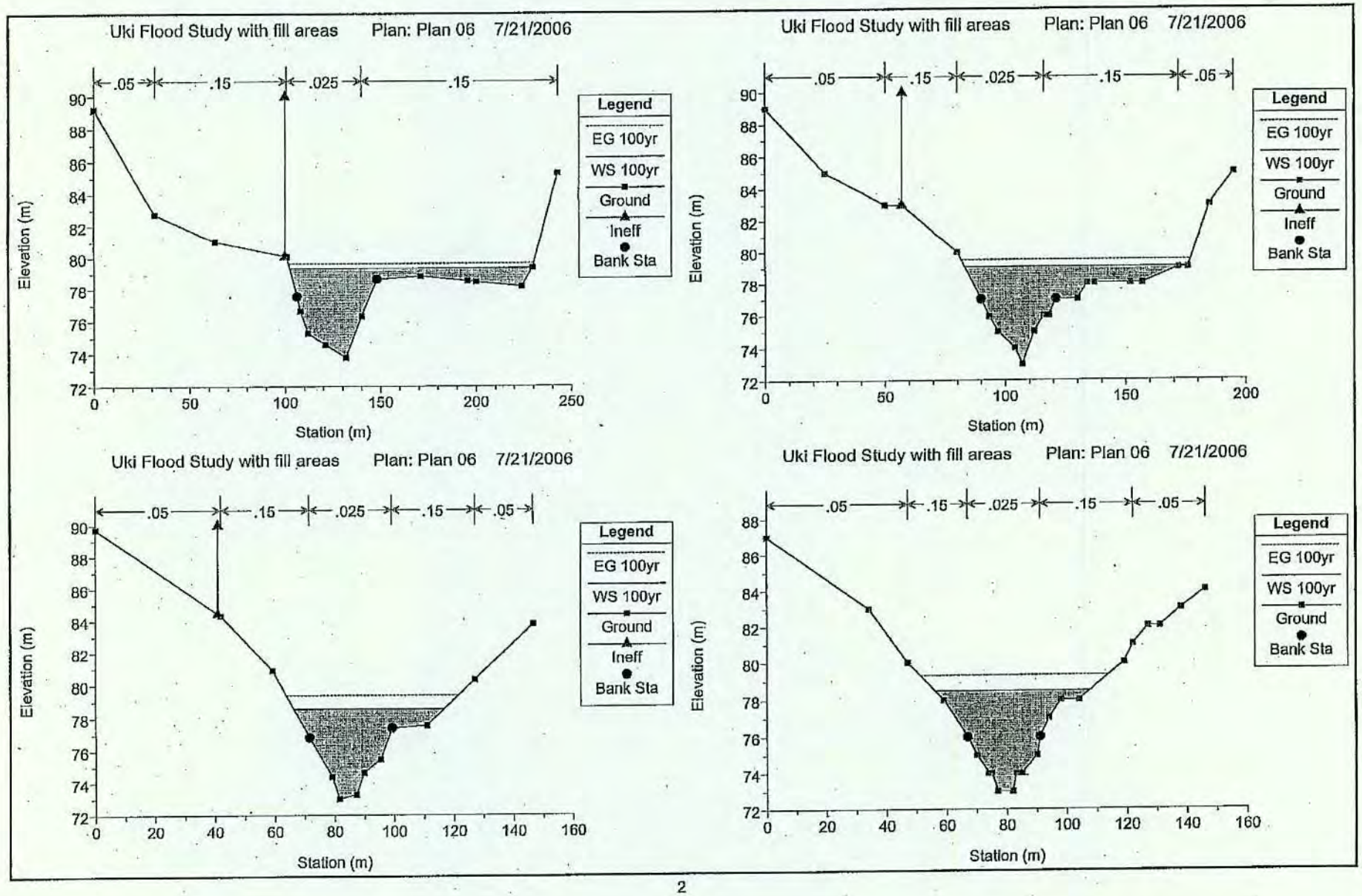
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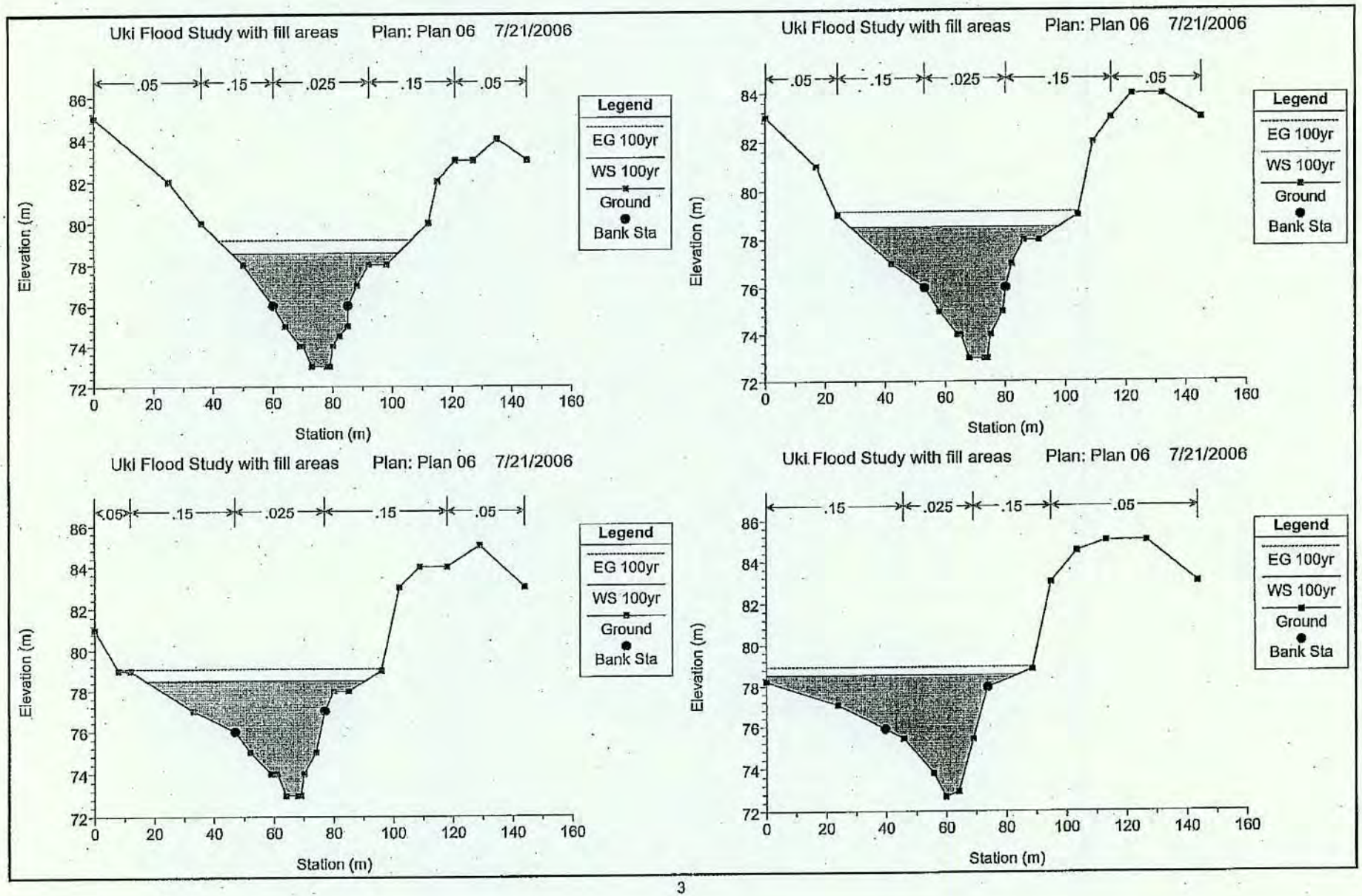
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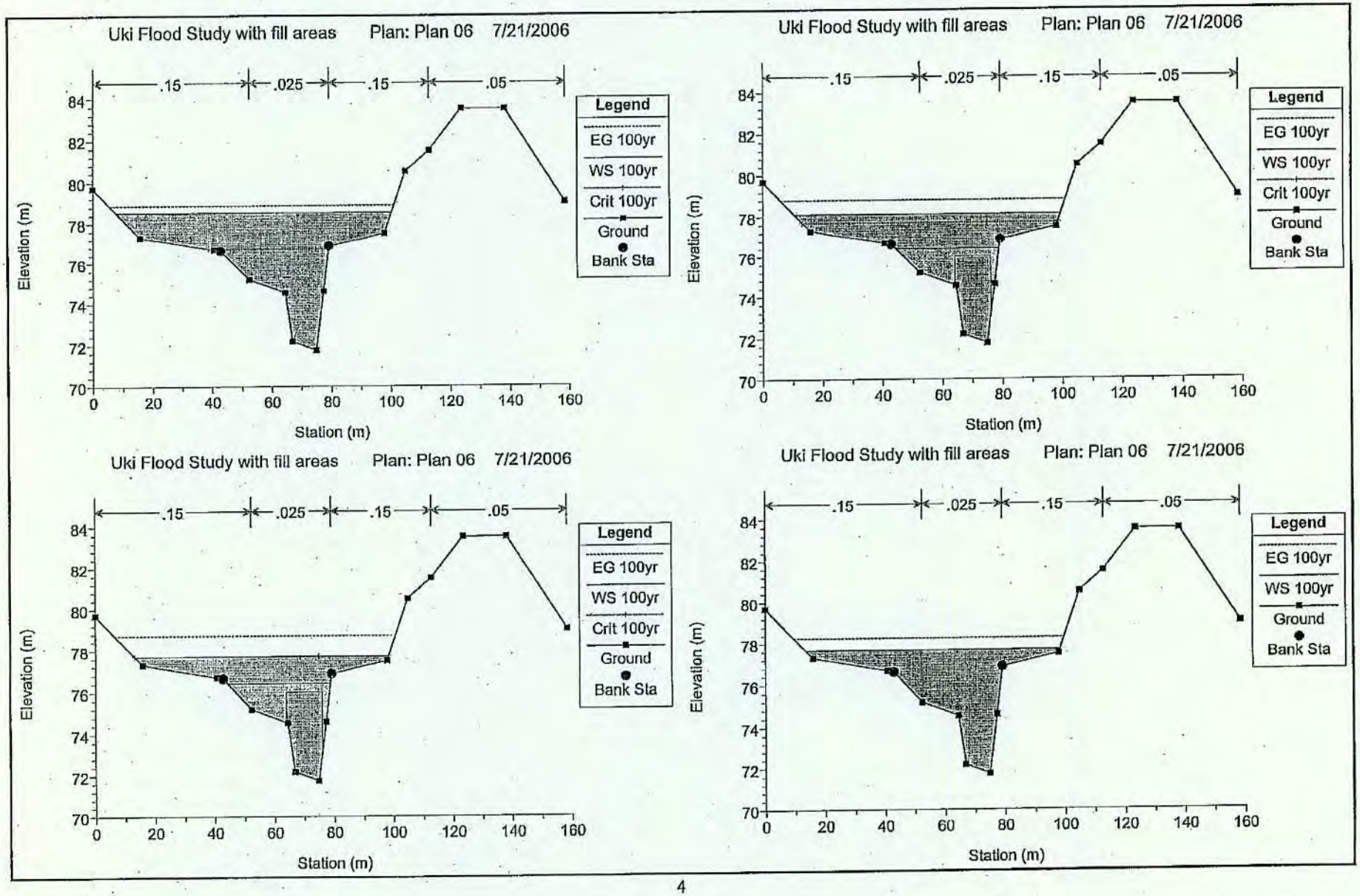
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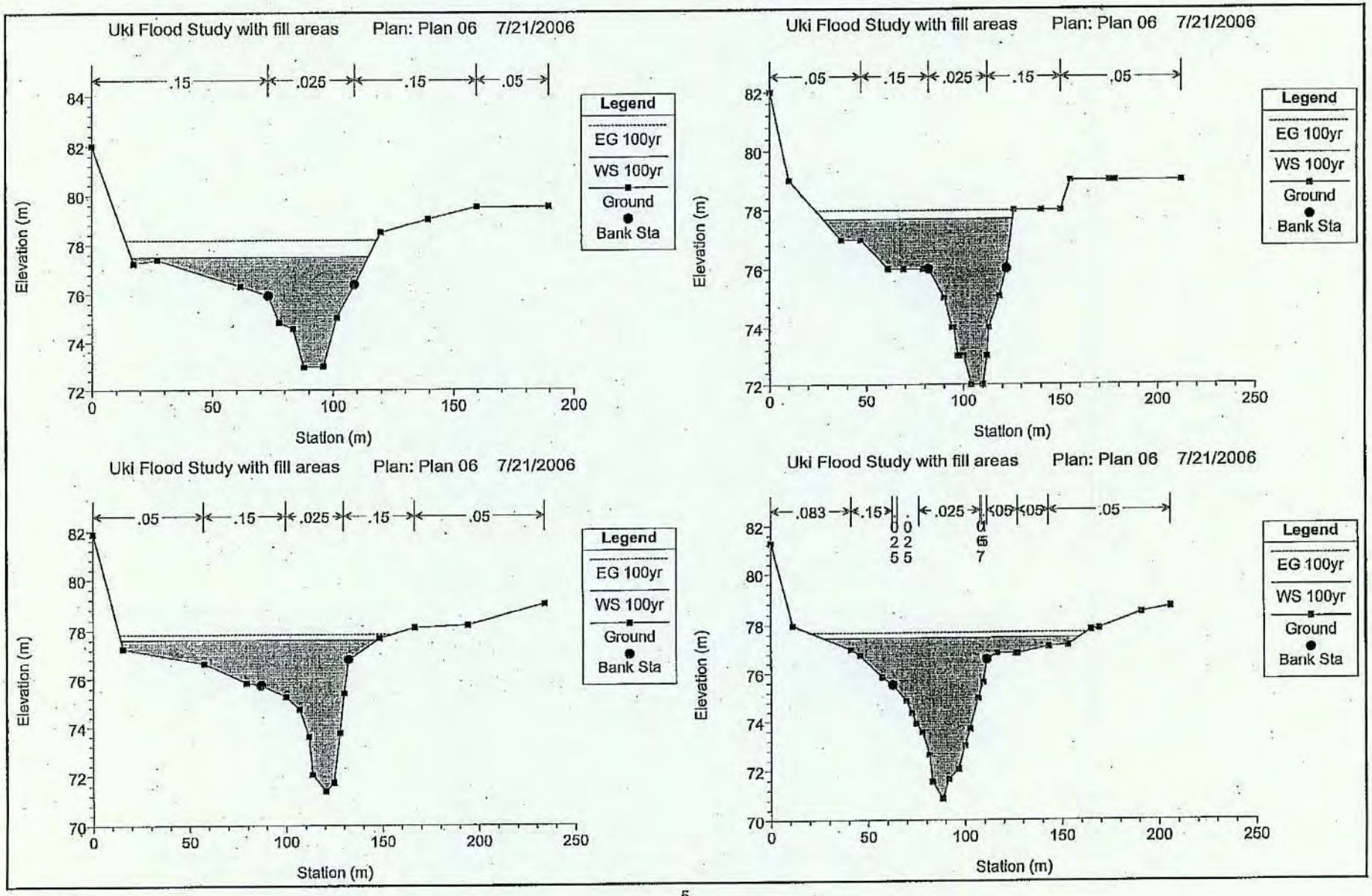
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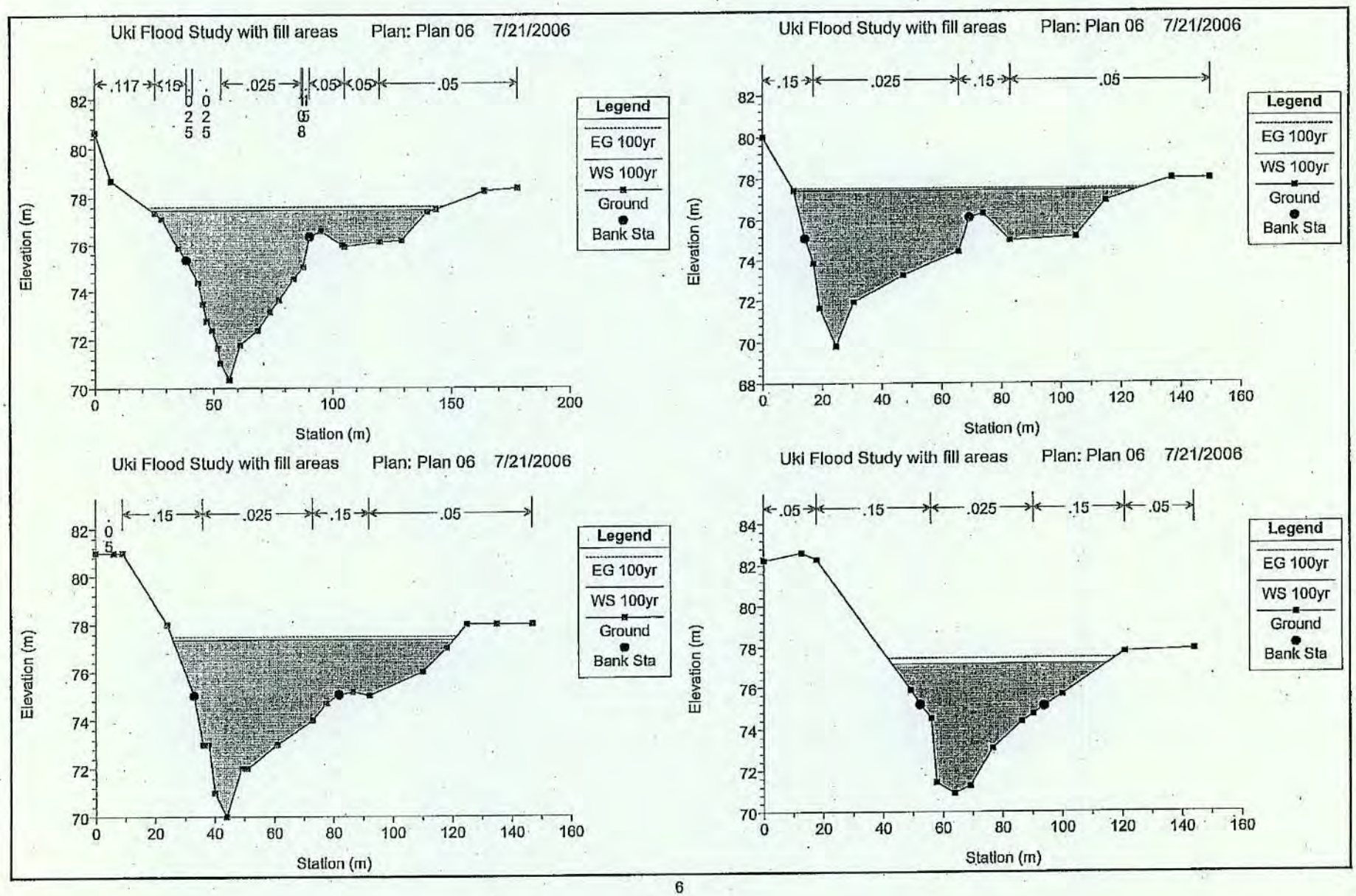
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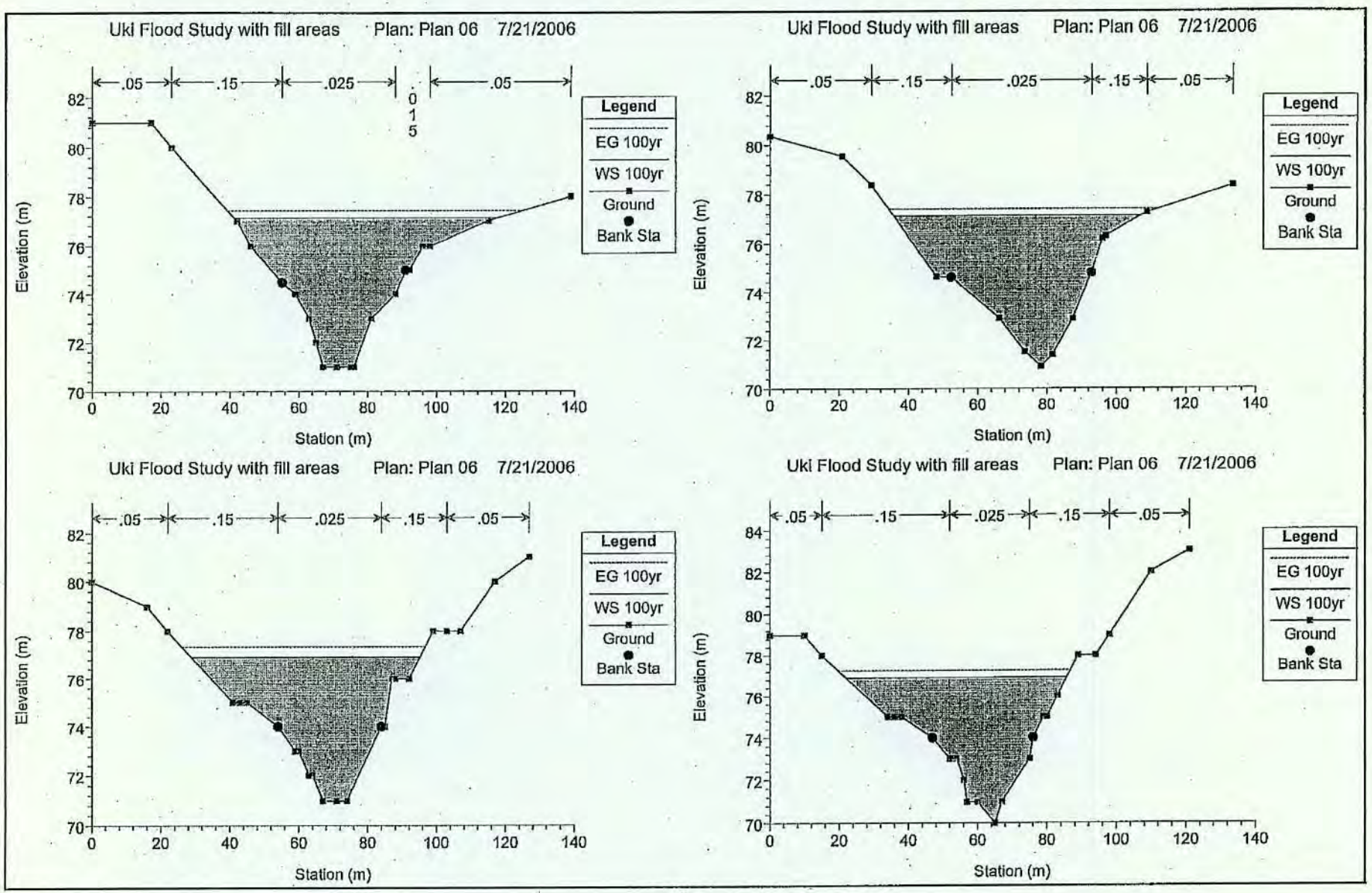
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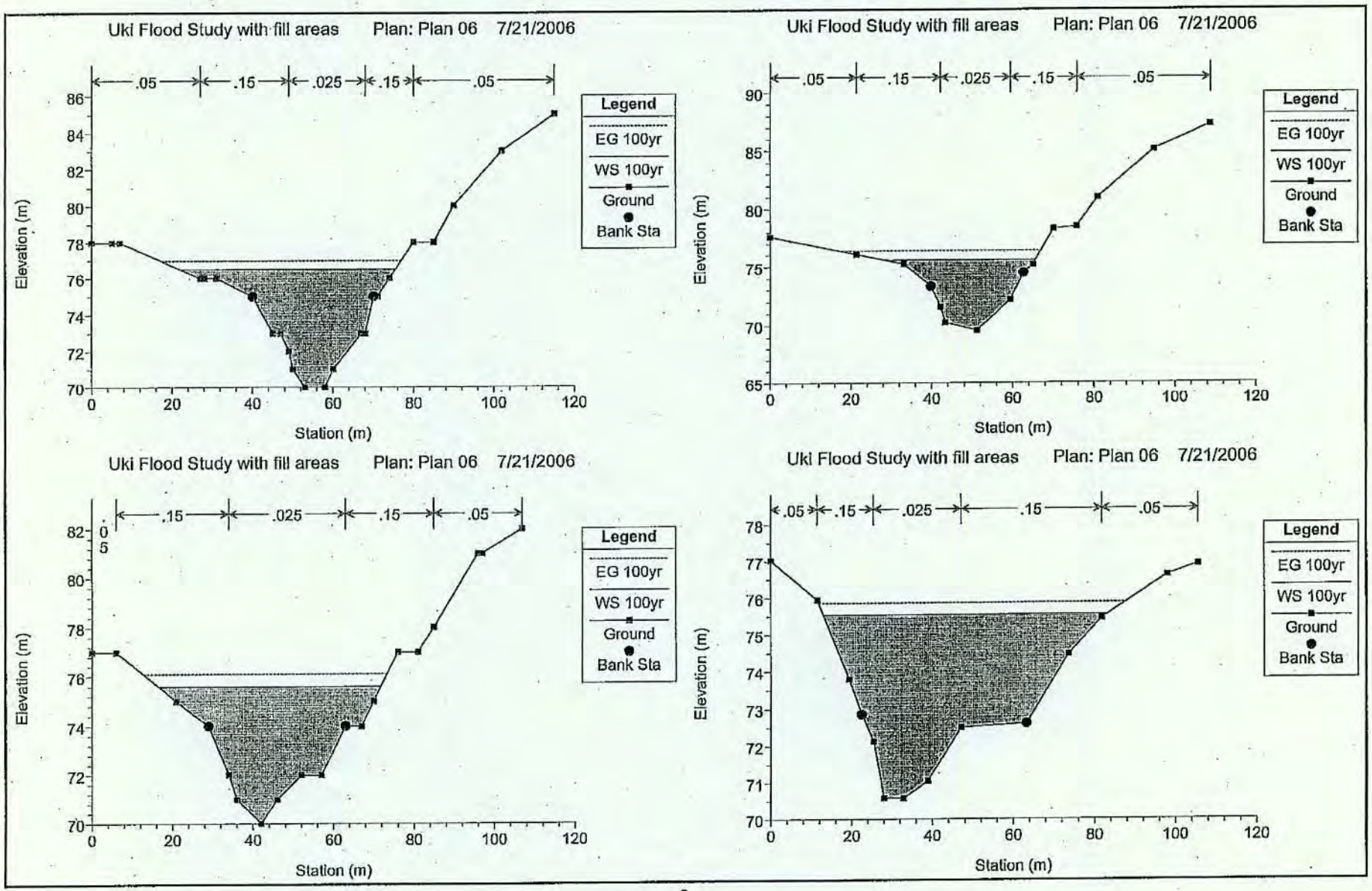
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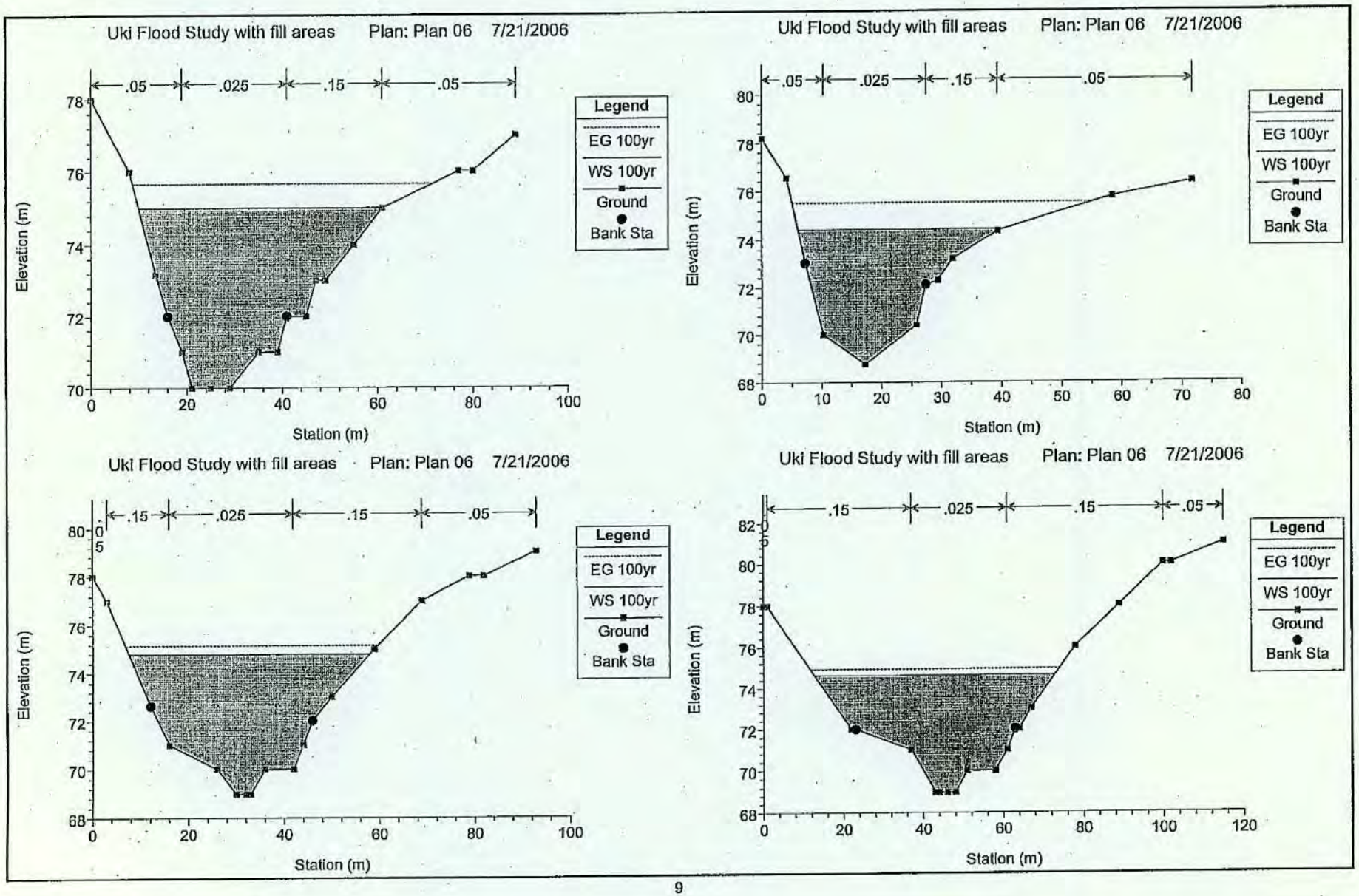
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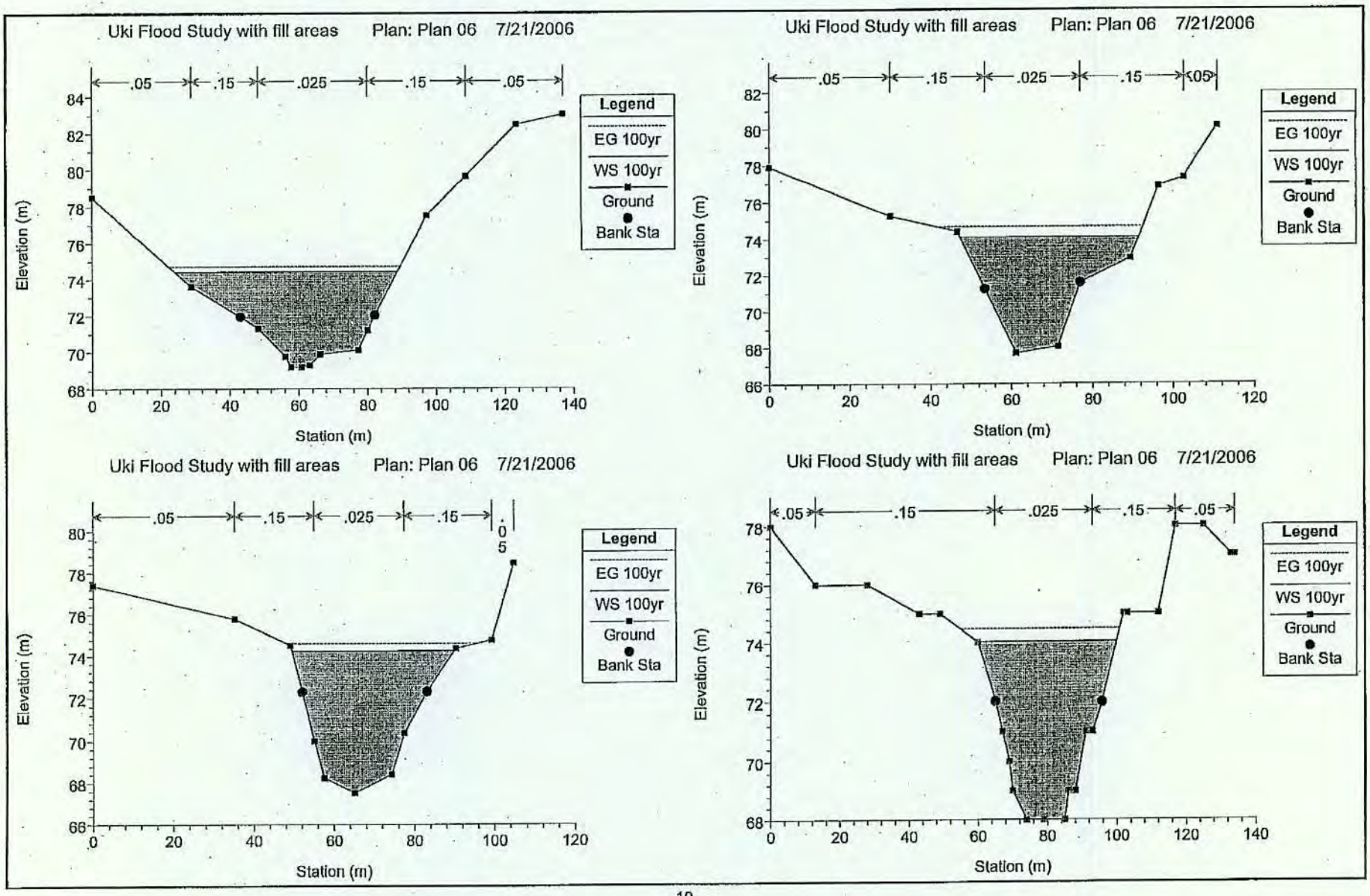
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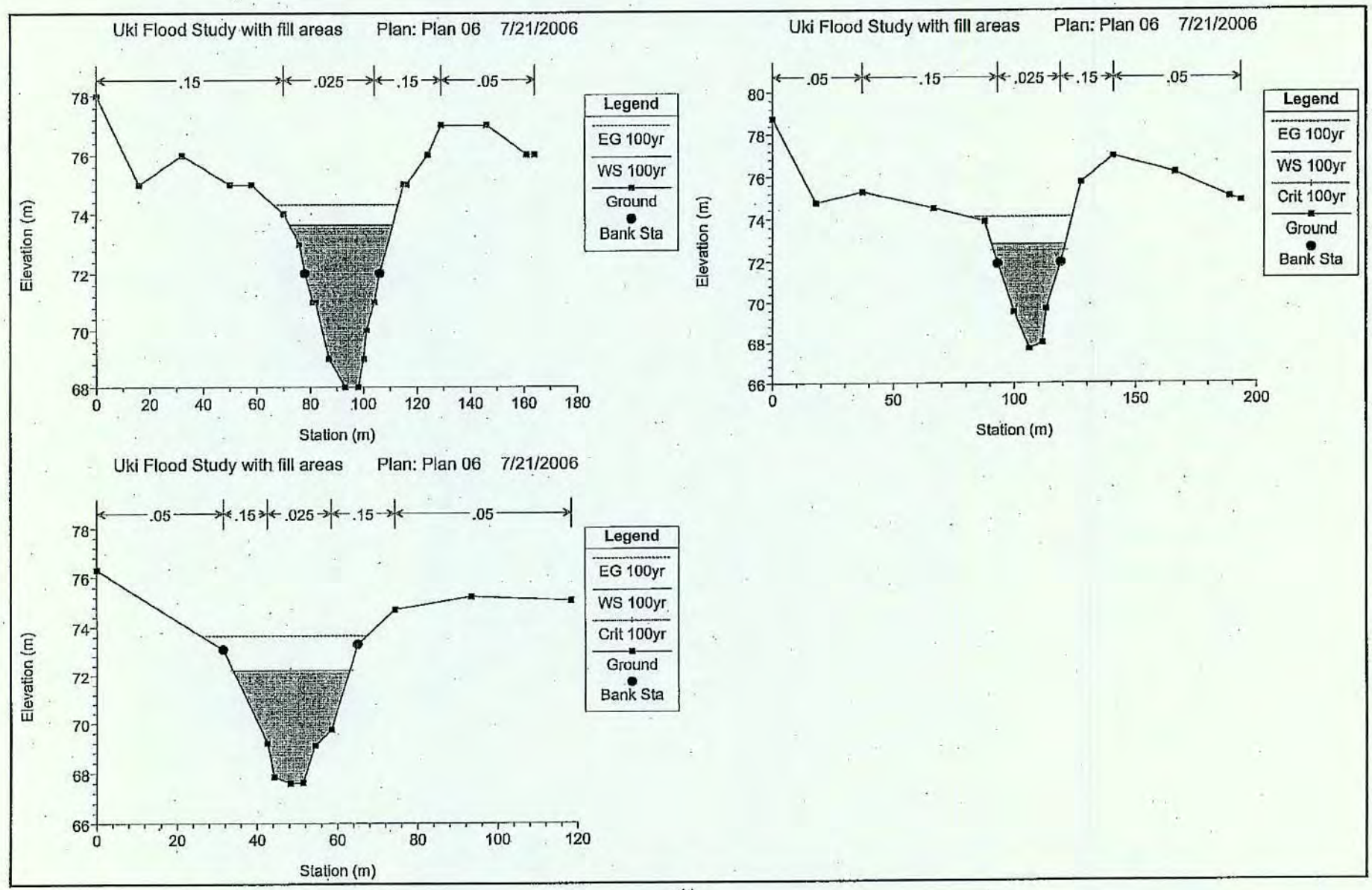
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7. NIGHTCAP VILLAGE BUSHFIRE MANAGEMENT PLAN

Cardno - 2006

Cardno
Engineering the Future

Nightcap Urban Village

Bushfire Management Plan

21 July 2006
Job No. 3500/53

Peter Van Lieshout

Cardno (Qld) Pty Ltd

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Document Control

Version	Date	Author		Reviewer	
		Name	Initials	Name	Initials
1	17 March 2006	Mark Harris	MH	John Delaney	KJD
2	April 2006	Mark Harris	MH	John Delaney	KJD
3	28 June 2006	Mark Harris	MH	John Delaney	KJD
4	21 July 2006	Mark Harris		John Delaney	

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NIGHTCAP URBAN VILLAGE
BUSHFIRE MANAGEMENT PLAN

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Figure 3 Proposed Plan of Development
Figure 4 Proposed Bushfire Management Measures

EXECUTIVE SUMMARY

This Bushfire Management Plan has been prepared by Cardno on behalf of Peter Van Lieshout in respect of Lot 3 on DP771335 and Lot 121 on DP134446, located on the Uki-Kyogle Road, Tweed Shire. This plan has been prepared in accordance with the provisions of the *Rural Fires Act 1997* and, more specifically, in accordance with:

- the New South Wales Rural Fire Service's *Planning for Bushfire Protection: A Guide for Councils, Planners, Fire Authorities, Developers and Home Owners*; and
- the *Tweed Shire Council Development Control Plan No. 16 – Subdivision Manual.*

The objectives of this report are to provide an analysis of the potential bushfire hazards of the site and its surrounds and to provide management strategies designed to mitigate the potential threat of bushfire.

This management plan provides:

1. In Section 2.0, an assessment of the vegetation and average slopes of the land within and external to the development envelope and recommendations concerning the appropriate type of development setbacks from potential bushfire threats.

2. In Section 3.0, a bushfire management plan which contains management specifications relating to the establishment of Asset Protection Zones, the appropriate standard to which buildings and structures should be constructed, the provision of water supply, the appropriate plant species to use as part of any landscaping within the site and general maintenance duties that should be undertaken by future residents to further reduce the potential for fires to spread into their property.

With respect to the latter point above, it is relevant to note that the Asset Protection Zones which are to be located along the western, northern and north-eastern boundaries of the Village zone are to be located external to the site within parcels of land which owned by Peter Van Lieshout. This provides an opportunity to ensure the ongoing function and maintenance of these external Asset Protection Zones is guaranteed in perpetuity. The areas encompassed by the external Asset Protection Zones are to be included as part of the Nightcap Rural Village development application, thereby enabling these specific bushfire management measures to achieve compliance with the intent and purpose of Section 4.2.1 of the Tweed Shire Council Development Control Plan No. 16 – Subdivision Manual which requires that "*asset protection zones are to be placed wholly within the subdivision they are intended to protect*".

1. INTRODUCTION

This Bushfire Management Plan has been prepared by Cardno on behalf of Peter Van Lieshout in respect of Lot 3 on DP771335 and Lot 121 on DP134446, located on the Uki-Kyogle Road, Tweed Shire ("the site"). This plan has been prepared in accordance with the New South Wales Rural Fire Service's *Planning for Bushfire Protection: A Guide for Councils, Planners, Fire Authorities, Developers and Home Owners* ("the RFS Guide"). This Bushfire Management Plan also addresses the bushfire management requirements contained within the *Tweed Shire Council Development Control Plan No. 16 – Subdivision Manual.*

1.1 Site Description

The site is located on the Uki-Kyogle Road, approximately 12km southwest of Uki and is situated on the Tweed River in a valley between Mt Warning and the Nightcap Ranges.

The site is bound:

- to the south by Uki-Kyogle Road, cleared land that is to support a rural residential development and to the south-west by a native plantation forest;
- to the north by cleared and partially cleared land and existing rural dwellings;
- to the east by cleared and partially cleared land and the Uki-Kyogle Road; and
- to the west by intact bushland that occurs on steep, easterly facing slopes.

A recent aerial photograph of the site is presented as Figure 1.

The vegetation across the majority of the site is dominated by pasture grassland with scattered clumps of trees. The majority of the site, including the clumps of trees, is highly disturbed, a consequence of past and recent vegetation clearance events and by the widespread invasion of exotic flora, principally Camphor laurel (*Cinnamomum camphora*). The site also supports riparian vegetation that fringes a section of the Tweed River which traverses the site's southern sectors.

The site has a "2(d) Village" designation pursuant to the *Tweed Local Environmental Plan 2000* ("*Tweed LEP*") which is classified as a "Residential" area.

The site is mapped as supporting *Vegetation Category 1* and *Buffer Zones (100m and 30m*) pursuant to Tweed Shire Council's *Tweed Shire Bush Fire Prone Land Map 1 of 2.* An excerpt of this mapping is presented as Figure 2. It is relevant to note that lawful vegetation clearance undertaken within the site has largely reduced the extent of vegetation coverage and, in this regard, the bushfire prone land mapping is no longer indicative of actual on-ground conditions. In this respect, reference is made to Figure 1 which illustrates the current extent of vegetation coverage within and external to the proposed development envelope.

1.2 Development Description

The proposed plan of development for the site, presented in Figure 3 would create the Nightcap Rural Village, which would consist of:

- Village Lots;
- Village Housing precinct;
- Mixed Village precinct;
- Tourism and Special Uses areas;
- Open Space areas (Village Green, Sports Display, Market Garden);
- Environmental Open Space;
- two centrally located dams;
- Parking; and
- Rehabilitation Areas.

The following development activities, of relevance to bushfire management issues, have already taken place within the site.

- The majority of the site has been cleared of vegetation and currently supports pasture grasslands with scattered clumps of forest trees and a narrow riparian corridor associated with the Tweed River.
- The provision of tracks which provide access from the Uki-Kyogle Road through the site to bushland situated to the west and a bituminised driveway associated with rural development to the north.

2. BUSHFIRE PROTECTION ASSESSMENT

Under current NSW legislation, the Rural Fire Service (RFS) has the responsibility of assessing the bushfire risk for urban development, and determining appropriate building setbacks and development controls to be applied. It does so in the context of the RFS Guide, which provides relevant information on bushfire risk in respect of vegetation type, topography and form of development.

Given the form of development proposed for the site (i.e. a rural village) and its proximity to existing bushland within the locality, it is necessary to undertake a Precinct Level Assessment in accordance with the specifications provided within Appendix 2 of the RFS Guide. Such an assessment is required to order to determine whether the development is bushfire-prone and, if so, the appropriate nature and width of any setbacks that are to be incorporated into the development layout. In order to complete this assessment, it is necessary to undertake the following procedures.

(a) Determination of vegetation distance, type and class, as follows:

  (i) identification of all vegetation in each direction from the site for a distance of 140m:

  (ii) consultation of the RFS Guide's Figure A2.2 and Table A2.1 to determine the vegetation type which predominates; and

  (iii) selection of the predominant vegetation group (1 to 3) as described in Table A2.1 of the RFS Guide.

(b) Determination of the average slope of the land between the Predominant Vegetation Class and the site (slope classes are detailed in section A2.2.5 of the RFS Guide).

(c) Consultation of Tables A2.2–2.4 within the RFS Guide and determination of the appropriate setbacks for the assessed land use, vegetation group and slope range.

These analyses are provided in Section 2.1 to 2.3 herein.

2.1 Vegetation Assessment

2.1.1 Vegetation Adjoining the Development Envelope

An assessment of vegetation within the vicinity of the site was completed between the 24th and 25th of January 2006. The aims of the survey were to:

- collate specific information on the vegetation types that occur within 140m of the site; and

- determine the equivalence that these vegetation types have to the Vegetation Groups (i.e. 1 to 3) specified in Figure A2.2 and Table A2.1 of the RFS Guide.

With respect to the above the following is noted.

1. Vegetation west of the site is mapped as a Grey Ironbark/White mahogany/Grey gum open forest complex pursuant to Map 2A0: Vegetation Type of the *Tweed*

Vegetation Management Strategy – August 2004. Site assessment confirmed the presence of this vegetation and noted the presence of a mid-dense to dense midstorey and understorey characterised by a variety of wet sclerophyll and rainforest plant species. It is also relevant to note that this vegetation community does not extend along the entire extent of the site's western boundary, with previously cleared and regularly slashed land abutting the western boundary in its central portion (adjacent to an existing track) and in its southern extent (to the north and south of the Tweed River). In general terms, the wet sclerophyll forest that borders the site's western boundary is considered to be analogous to Vegetation Group 1 pursuant to Table A2.1 of the RFS Guide. The cleared land that abuts the central and south-western boundary of the site is considered to be analogous to Vegetation Group 3 pursuant to Table A2.1 of the RFS Guide.

2. Vegetation south of the site is characterised by a thin band of wet sclerophyll forest associated with a road reserve, a native forest plantation and cleared grasslands associated with a proposed rural residential community. It is relevant to note that although the native forest plantation and the cleared land are physically separated from the site by the Uki-Kyogle Road, there is only slight canopy separation between the thin band of wet sclerophyll forest associated with the road reserve and the native plantation. In this respect, it is considered that the Uki-Kyogle Road would have little impact in terms of slowing or halting an approaching fire-front from the south if such a fire was to crown. The thin band of wet sclerophyll forest and the native forest plantation are considered to be analogous to Vegetation Group 1 and the cleared land is considered to be analogous to Vegetation Group 3 pursuant to Table A2.1 of the RFS Guide.

3. Vegetation to the east and north of the site is characterised by predominantly cleared grasslands that support scattered clumps of vegetation and isolated trees. In this respect, the predominant vegetation type adjoining the site along these two boundaries is considered analogous to Vegetation Group 3 pursuant to Table A2.1 of the RFS Guide.

The distribution of vegetation categorised under the RFS Guide's grouping strategy that adjoins the development envelope is presented in Figure 4.

2.1.2 Vegetation Within the Development Envelope

It is relevant to note that, under the proposed plan of development (refer Figure 3) clumps of forest trees within the northern portions of the site are to be retained. In this respect, Section A2.3.4 in Appendix 2 of the RFS Guide states that "*small remnant forest areas (less than 1 ha) may be considered equivalent to specifications in Vegetation Group 3*". Although these clumps of forest trees are not considered to constitute a significant bushfire threat, it is recognised that there exists the potential for these clumps to ignite as a consequence of air-born ember attack from approaching fire fronts outside of the site's boundaries. As such, these retained clumps are appropriately categorised as low-risk bushfire hazards (i.e. Vegetation Group 3).

The narrow riparian corridor that fringes the Tweed River is to be retained and rehabilitated through enhancement plantings and, where relevant, widened, as part of the proposed development. This riparian corridor is considered analogous to the closed forest description provided on Figure A2.2 and in Table A2.1 of the RFS Guide and, as such, constitutes Vegetation Group 3.

The distribution of vegetation categorised under the RFS Guide's grouping strategy within the development envelope is presented in Figure 4.

2.2 Slope Assessment

The site is situated over steep and undulating land in a valley formed between the Mount Warning and Nightcap National Parks. Slopes on land adjoining the site's four boundaries are described as follows.

1. Land to the west is situated on steep gradients (i.e. >5°) and occurs upslope of the site.
2. Land south of the Tweed River is situated upslope of the site on gradients >5°.
3. Land to the east is situated on undulating land that slopes down to the Tweed River such that land along the site's south-eastern boundary occurs upslope on gradients >5°, and land along the site's north-eastern boundary occurs downslope of the site on gradients >10-15°.
4. Land to the north is situated on undulating land that slopes down to a natural drainage channel, part of which flows through the north-eastern corner of the site. It is also relevant to note that a large constructed dam occurs slightly upslope of the site and contributes to another natural drainage channel that flows through the north-western and central-northern sections of the site. In general terms, land to the north occurs upslope of the site on slopes varying between 0-5° and >5°.

2.3 Setback Assessment

2.3.1 Overview

Minimum specifications for setbacks or Asset Protection Zones (APZs) for residential developments in bushfire prone areas are provided in Tables A2.2 and A2.4 of the RFS Guide. It is considered that the minimum specifications provided in Table A2.3 are not applicable to the proposed Nightcap Rural Village, as it is not being developed specifically to provide one of the following "Special Protection" purposes:

- housing for older people or people with a disability;
- schools, institutions for mentally and /or physically disabled;
- residential aged care facilities (nursing homes & hostels); or
- child care facilities.

With respect to the above, an APZ is defined in the RFS Guide as *an area surrounding a development managed to reduce the bushfire hazard to an acceptable level*...[and] *to protect human life, property and highly valued public assets and values.* An APZ consists of an Inner Protection Area (IPA) and an Outer Protection Area (OPA). The width of an APZ varies with vegetation type, slope and construction level.

An IPA is described as the inner component of an APZ, consisting of an area maintained to minimal fuel loads and comprising a combination of perimeter road, fire trail, rear yard or reserve, so that a fire path is not created between the hazard and the building.

An OPA is described as the outer component of an asset protection zone, where fuel loads are maintained at a level (usually less than 8 t/ha) where the intensity of an approaching bushfire would be significantly reduced.

It is relevant to note that Section 4.2 of the RFS Guide, which outlines provisions that should be taken into consideration under s.79C of the *Environmental Planning and Assessment Act 1979* when a development application is to be determined for a residential subdivision, and which specifically addresses APZs, states:

> *Bushfire protection measures that are essential to a development must occur on the site of the proposed development unless the most exceptional circumstances apply. This has been supported by various court rulings, including* Scott Revay & Unn v.Ku-ring-gai Municipal Council 1994, Williams v Blue Mountains City Council 1995 and Spargo v Wollongong City Council 1997.

It is also relevant to note that Section 4.2.1 of the Tweed Shire Council Development Control Plan No. 16 – Subdivision Manual also states that "*asset protection zones are to be placed wholly within the subdivision they are intended to protect*".

2.3.2 Application

The APZs proposed along the western, northern and north-eastern boundaries of the Village zone are to be located external to the site within parcels of land which, like the site, are owned by Peter Van Lieshout. The ownership of the land is of relevance as it provides an opportunity to ensure the ongoing function and maintenance of the external APZs is guaranteed in perpetuity. It is also relevant to note that the areas encompassed by the external APZs are to be included as part of the Nightcap Rural Village development application, thereby enabling these specific bushfire management measures to achieve compliance with the intent and purpose of Section 4.2.1 of the Tweed Shire Council Development Control Plan No. 16 – Subdivision Manual which requires that "*asset protection zones are to be placed wholly within the subdivision they are intended to protect*".

The approximate locations of the development setbacks (i.e. APZs) to Group 1 and 3 vegetation adjoining and within the development site are presented in Figure 4. It is not considered necessary to establish an APZ along the south-eastern boundary of the site, as, in this respect, the Uki-Kyogle Road will function as an APZ. Details relating to the required setbacks of development from Group 1 and 3 vegetation within and adjoining the site are provided as follows.

Group 1 Vegetation APZ

Pursuant to Table A2.2 of the RFS Guide, the minimum width of an APZ located between a development boundary and Group 1 vegetation situated upslope of a development boundary on gradients greater than 5° is 20m. Table A2.2 also specifies that such an APZ should be comprised of a 20m wide IPA and that there is no need to provide an OPA. It is relevant to note that this setback is based upon the need for buildings constructed adjacent to the APZ to conform with a Level 3 construction standard pursuant to *Australian Standard AS 3959 – 1999 Construction of buildings in bushfire-prone areas* ("*AS 3959 – 1999*"). In this respect, Level 3 construction pertains to the category of extreme bushfire attack. Appendix 2 of the RFS Guide states that if it is intended to construct to a lower bushfire protection standard (i.e. Level 1, which pertains to the category of medium bushfire attack, or Level 2, which pertains to the

category of high bushfire attack) or to no specific bushfire protection standard, then an APZ of greater width will be required.

Setbacks to Group 1 vegetation adjoining the development will be required along the site's south-western and north-western boundaries and are shown in Figure 4.

Group 3 Vegetation APZ

Pursuant to Table A2.4 of the RFS Guide, a minimum separation distance of 20m (managed understorey or grasses) should be established between a development boundary and Group 3 vegetation on all slopes. Table A3.3 of the RFS Guide does not require that a specific standard, pursuant to *AS 3959 – 1999*, be adopted for buildings constructed adjacent to APZs established between development and Group 3 vegetation.

Setbacks to Group 3 vegetation adjoining the development will be required along the site's eastern and northern boundaries. Setbacks to Group 3 vegetation within the development will be required along the Tweed River and around retained clumps of vegetation. Group 3 vegetation APZs are illustrated in Figure 4.

With respect to the development setbacks from the clumps of forest trees and riparian vegetation to be retained within the site the following is noted.

1. It is recognised that as the site has a "Village" designation pursuant to the *Tweed LEP* and, as such, vegetation clearance within the site is exempt from the provisions of the *Native Vegetation Act 2003*. Whilst it is recognised that other regulations (i.e. the *Threatened Species Conservation Act 1995, Environmental Planning and Assessment Act 1979*, *Fisheries Management Act 1994* and *Rivers and Foreshores Improvement Act 1948*) would constrain the complete removal of vegetation from within the site, it is acknowledged that the possibility exists that some of the forested clumps may be removed as a consequence of the development. In the instance that these or the other communities identified as Group 3 vegetation within the site are removed, there would be no requirement to establish a 20m wide APZ in the locations indicated in Figure 4.

2. Given the form of development proposed for the site, it would be appropriate to establish a 6m wide fire-trail as close as possible to the vegetation retained within the site (refer Figure 4). These fire-trails should be constructed in a manner responsive to site topography and, where practicable, should have:

   a) a formed width and gradient;

   b) erosion control devices to local government standards; and

   c) provisions for passing bays and turning areas for fire-fighting appliances.

   The fire-trail should be regularly slashed and, where practicable, be of a form suitable to cater for the deployment of fire-fighting vehicles. Provided such fire-trails are established and maintained, it is considered that it would be suitable to construct non-habitable structures within the balance of the APZ. However, in this regard, it is recommended that the RFS be consulted about the practicalities of such a measure and about the whether there would be a need to construct such structures to a certain standard pursuant to *AS 3959 – 1999*.

3. BUSHFIRE MANAGEMENT PLAN

Subdivision of land for residential use in bush fire prone areas constitutes "integrated development" and requires authorisation under s.100B of the *Rural Fires Act 1997* in respect of bush fire safety. In this respect, the *Tweed Shire Council Development Control Plan No. 16 – Subdivision Manual* requires that a Bushfire Management Plan must accompany the development application for subdivision and must:

- ensure that streets and fire trails are designed, located and connected to allow safe and efficient movement for emergency vehicles and evacuation;
- provide appropriate perimeter roads or reserves to circumscribe the hazard side of the development with appropriately owned and managed asset protection zones between the source of bushfire risk and urban development;
- design lots to facilitate the siting and design of houses incorporating bushfire protection measures; and
- comply with the provisions of *Development Design Specification D10 - Bushfire Protection*.

In this regard, the following bushfire management measures are recommended for implementation as part of the proposed development.

3.1 Asset Protection Zone Management and Maintenance

In order to achieve compliance with the purposed and intent of the RFS Guide, APZs should be located in those areas of the site indicated in Figure 4.

A network of access roads is to be established within the development envelope. An indicative layout of the roadway system proposed is illustrated in Figure 3. The precise alignments of these roadways and walking trails within the development are to be determined during the detailed design phase of development. Irrespective of this, the intent is to use these roadways and walking trails as fire-breaks and fuel reduced zones and, as such, they will also function to inhibit movement of fire into the development envelope.

Where roadways are not located within the defined APZs, fire-trails should be established as close as possible to the adjoining bushfire hazard within all APZs to facilitate the deployment of fire-fighting units. It is recognised that the site is situated over steep and undulating land and that, in this respect, it will not be possible to establish fire-trails within all APZs that will be of a form suitable to cater for the deployment of fire-fighting units. In this regard, fire-trails should be constructed in a manner responsive to site topography and, where practicable, should have the following minimum design characteristics:

a. a minimum cleared width of 6 metres;
b. a formed width and gradient to local government standards;
c. unrestricted vehicular access at each end; and
d. passing bays and turning areas for fire-fighting appliances.

The balance of the APZs are to consist of a fuel reduced zone within which existing vegetation is to be selectively cleared and maintained in a condition that will inhibit the movement of fire from adjacent bushland into the development. In this respect vegetation within the fuel reduced zone shall be selectively cleared and maintained to the following standards:

a. all trees with a stem diameter in excess of 150mm are to be retained, unless their removal is required to facilitate the establishment of fire trails;
b. all trees with a stem diameter less than 150mm and all shrubs are to be removed;
c. all dead trees and accumulated combustible debris are to be removed; and
d. the ground cover vegetation, and any regrowth of trees and shrubs, is to be maintained to a height of not more than 150mm.

3.2 Buildings and Structures

As stated in Section 2.3.2, there is a requirement for any dwellings and other structures established immediately adjacent to the 20m wide APZ that separates Group 1 vegetation from the development boundary to conform to a Level 3 construction standard pursuant to *AS 3959 – 1999*. If a lower or no construction standard is adopted, there will be a need, pursuant to the recommendations provided within Appendix 2 of the RFS Guide, to incorporate wider APZs between the Group 1 vegetation and the development boundary.

Table A3.3 of the RFS Guide does not require that a specific standard, pursuant to *AS 3959 – 1999*, be adopted for buildings constructed adjacent to APZs established between development and Group 3 vegetation. The RFS should be consulted about the need to construct structures to a certain standard pursuant to *AS 3959 – 1999* if such structures are proposed:

a. within those APZs to be established around the perimeter of vegetation retained within the site; and
b. outside of the recommended 6m wide fire-trail established as close as possible to the edge of vegetation retained within the site.

There is no requirement to construct dwellings and other structures within the balance of the site to a specific standard pursuant to *AS 3959 – 1999*.

3.3 Access

As shown in Figure 3, the proposed development would incorporate a ring-road design that would enable future residents to access/egress the site via two entry/exit points to the Uki-Kyogle Road.

As previously stated in Section 3.1, additional emergency access would be provided adjacent to potential bushfire hazards in the form of minimum 6m wide fire-trails that would be established within the APZs. These fire-trails would be clearly sign posted, to facilitate navigation by emergency services. Further detail regarding the fire-trails is provided in Section 3.1.

3.4 Water Supply

The proposed development will be serviced by its own reticulated water supply and, as such, residents will not be reliant upon on-site water storage to meet their domestic, including fire fighting/suppression, requirements.

3.5 Landscaping Within the Development

It is recognised that, as part of the proposed development, open space areas within the site are to be landscaped with native flora species. It is also recognised that some future residents of the site may wish to maintain or establish vegetation within areas close to their own dwellings. It is suggested that any landscaping or other establishment of vegetation within the site be undertaken in accordance with "green firebreak" principles, to compliment existing fuel reduced zones and to provide a shield against windborne embers and to absorb radiant energy from approaching bushfires.

The concept of green firebreaks follows the knowledge that species less adapted to drier conditions, and subsequently less frequent fire, have generally higher moisture content, and require larger amounts of energy to dry and ignite. This presents a less flammable barrier to the spread of fire, and can trap burning embers long enough for them to burn-out in the moister vegetation. Conversely, these green firebreaks are usually killed by the fire and may require replacement, depending upon species selected.

While the list of potential species and their most effective arrangement can vary with location, the following general points should be followed.

- Generally, rainforest or scrub species provide the most effective heat-shield.
- Species should be utilised that, when mature, will produce vegetation associations that are equivalent to Vegetation Group 3 (refer Table A2.1 of the RFS Guide) and that will produce ground fuel loads of less than 5 t/ha.
- Avoid the use of exotic species or species with a potential for escape and infestation unless they are to be well maintained and controlled.
- Species endemic to the area should be used as they will not only grow better in local conditions but also may add to the habitat value of the property.
- When planting, avoid creating gaps and tunnels in the break that allow embers to pass through.
- Maintain fuels at ground level to a minimum level to increase the effectiveness of the break.

3.6 General Maintenance

Prior to the onset of the normal bushfire season, which usually extends from September to February, there are a number of general property maintenance actions that landowners should undertake to further reduce the potential for fires to spread within their property. These maintenance actions include:

- Ensuring that any firebreaks are in an appropriate condition.
- Cleaning all gutters and eves regularly, and removing debris from roofs.
- Keeping yards tidy and regularly raking beds and landscaping close to structures clear of fine fuel.
- Checking that any sprinkler or irrigation sprays are working correctly.
- Checking that window shutters and screens fitted to openings are in good repair.
- Making sure that adequate protective clothing (i.e. sturdy boots, overalls, and face-masks to filter heavy smoke) is at hand for use in the event of a fire.
- Ensuring all sheets are securely in place, if the roof is made of sheet metal. If the roof is tiled, ensuring there are no loose tiles and that embers cannot be driven between them.
- Carefully considering the storage of dangerous and flammable materials around the property to guard against ignition during a fire. This includes materials under kitchen and laundry sinks and in cupboards.
- Preparing a list of contingency procedures in the event of a fire and ensuring all household members are familiar with them. Combined, attention to all of the actions recommended above will provide the best available protection against damage from bushfires.

FIGURES

Figure 1 **Aerial Photograph**

Figure 2 **Excerpt from the Tweed Shire Bushfire Prone Land Map 1 of 2**

Figure 3 **Proposed Plan of Development**

Figure 4 **Proposed Bushfire Management Measures**

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LEGEND

Cadastral boundaries

60 0 60 120 180 240 300m
1:6000

Scale 1:6000 (A4)

FIGURE 1
AERIAL PHOTOGRAPH

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Project No.: 3500/53

Peter Van Lieshout

CAD FILE: I:\3500-53\ACAD\Bushfire Management Plan\Figure 1 - Aerial Photograph.dwg
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PRINT DATE: 15 June, 2006 - 4:10pm

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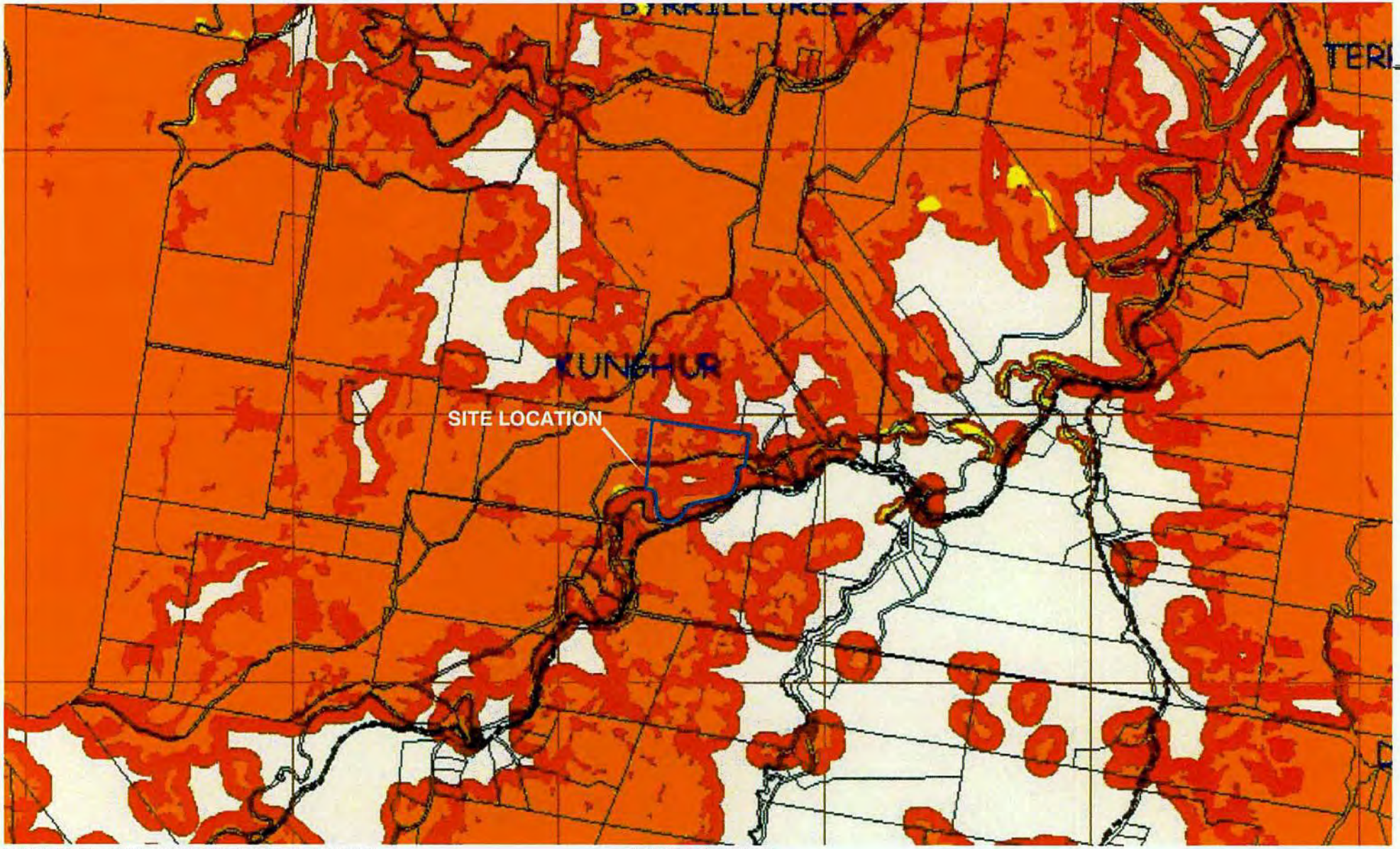

Image Sourced from: Map 1 or 2 Tweed Shire Fire Prone Land Feb 2004 - "Tweed Shire Council"

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Bush Fire Prone Land Map - Legend

- Bush Fire Prone Land - Vegetation Category 1
- Bush Fire Prone Land - Vegetation Category 2
- Bush Fire Prone Land - Buffer Zones - 100m and 30m
- Major Roads
- Tweed Shire Boundary
- Property Boundaries

FIGURE 2
EXCERPT FROM THE TWEED SHIRE BUSHFIRE PRONE LAND MAP 1 OF 2

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Project No.: 3500/53

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CAD FILE: I:\3500-53\ACAD\Bushfire Management Plan\Figure 2 - Excerpt from the Tweed Shire Bushfire Prone Land Map 1 of 2.dwg
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CONCEPT PLAN

LEGEND

- VILLAGE LOTS
- VILLAGE HOUSING
- MIXED VILLAGE
- TOURISM AND SPECIAL USES
- OPEN SPACE (Village Green, Sports Display, Market Garden)
- ENVIRONMENTAL OPEN SPACE
- REHABILITATION AREA
- P PARKING
- SITE BOUNDARY
- RIVER CORRIDOR

Image Sourced from: Malcolm Middleton Architects Pty Ltd

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Scale N.T.S

FIGURE 3

PROPOSED PLAN OF DEVELOPMENT

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LEGEND

- Cadastral boundaries
- Vegetation Group 1 (within 140m of development boundary)
- Vegetation Group 3 (within 140m of development boundary)
- Vegetation Group 3 (within development)
- 20m Wide APZ setback from Vegetation Group 1
- 20m Wide APZ setback from Vegetation Group 3
- 6m Wide Fire Trail

40 0 40 80 120 160 200m 1:4000

Scale 1:4000 (A3)

FIGURE 4

PROPOSED BUSHFIRE MANAGEMENT MEASURES

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8. STORMWATER MANAGEMENT PLAN

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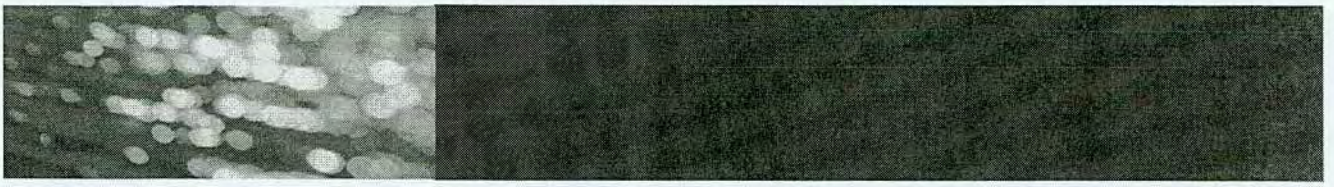

Nightcap Village, Uki

Stormwater Management Plan

30 June 2006
Job No. 3500/53

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Document Control

Version	Date	Author		Reviewer	
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1	18 May 2006	Sid Duty	SD	Martin Giles	MG
2	16 June 2006	Sid Duty	SD	Martin Giles	MG
3	30 June 2006	Sid Duty	SD	Martin Giles	MG

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NIGHTCAP VILLAGE, UKI
STORMWATER MANAGEMENT PLAN

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APPENDICES

APPENDIX A Music Parameters

1. INTRODUCTION

Peter Van Lieshout propose to develop a site on Kyogle Road in the Kunghur area of north-eastern New South Wales to create a residential village. The site falls within the jurisdiction of Tweed Shire Council, and as the site is adjacent to the Tweed River, an assessment is required to ensure that the development has no adverse effects on the Tweed River in terms of runoff quantity or quality. This report details Cardno's advice in this regard.

The site, of over 45 hectares in area, is currently characterised by pockets of woodland among open grassland. Development proposals include residential lots of varying density, with accompanying recreational and commercial areas. An increase in impermeable area and human activity across the site has the potential to increase both the rate of runoff, and the pollutants entrained within it. To overcome this, a conceptual treatment train has been developed that encompasses water sensitive urban design principles.

The proposed development will be constructed in three stages, each being 'self sufficient' in terms of runoff quantity and quality. All stages will include rainwater tanks for roof areas, buffer strips to treat lot drainage, infiltration trenches to deal with road runoff, and proprietary gross pollutant traps to remove litter and debris. All runoff from events of up to the three-month return period will finally filter through bioretention basins before release to the watercourse, providing a high quality discharge with no detriment to the receiving waters.

Stormwater detention measures will be employed to ensure that there is no overall increase in the rate of runoff from the site, avoiding flooding problems downstream. Existing dams will be utilised to store stormwater for controlled release, and new facilities will be constructed as appropriate (often being combined with the bioretention systems described above).

The proposed site and its treatment systems have been modelled using MUSIC 3.01. It demonstrates that development can proceed without producing an increase in the total annual export of pollutants from the site when compared to the existing situation. Further, the proposed system will meet accepted efficiency standards for the removal of key pollutants.

For the analysis, stormwater quantity issues were considered in accordance with the requirements of Tweed Shire Council Development Control Plan 16, and quality issues considered in accordance with Development Design Specification D7. The final type, capacity and dimensions of the devices will be subject to detailed design at a later stage.

2. STORMWATER QUANTITY

2.1 Methodology

Peak discharges were calculated using the Rational Method, in accordance with *Australian Rainfall and Runoff* (Institute of Engineers Australia, 1987), after having established the areas of each zone. Design rainfall intensities were calculated with AUS-IFD software, using the parameters set out in Table 1.

Table 1 Rainfall Parameters for

Log Normal Intensities				Geographical factors	
2 year ARI		50 year ARI			
1 hr	47.5	1 hr	88	Skewness G	0.075
12 hr	11.9	12 hr	25	F2	4.4
72 hr	4	72 hr	9.5	F50	17

The primary design aim is to ensure that runoff rates downstream of the site do not increase following development, both to prevent scour in existing watercourses and to prevent possible flooding problems. This is achieved by providing a storage area that detains the increased runoff flow, releasing it in a controlled manner at a rate that resembles the situation prior to development.

2.2 Management of Stormwater Runoff

The Rational Method was used to determine the peak 100-year event discharge in both the existing and developed cases.

This study analyses the entire site using the three construction stages proposed by the developer. The first of these, to the northwest of the site, features areas of low and medium density residential development, and includes the majority of the 'mixed village' zone, which will include commercial areas. The stage also features a recreational area and two waterbodies. As well as providing an aesthetic and recreational asset for the development, the waterbodies will be used for stormwater attenuation.

The second area, to the northeast of the site, also features low and medium density residential development. This stage also includes a large sports pavilion and several carparking areas. The majority of the stage is below the level of the aforementioned waterbodies and will therefore require dedicated attenuation measures.

Lastly, the third southern stage features more medium density housing, and the remainder of the mixed village zone. This stage includes the River Tweed itself, as it flows from the west to east through the site. The lowest of the stages, attenuation devices will also be required, set above the 100-year flood level of the River Tweed.

2.2.1 Impervious areas

The whole site is assumed to be completely pervious in its current state. Time of concentration has been estimated using Friend's equation, and taken to be 30 minutes for all of the stages.

Following development, the site will be impervious to differing degrees. The calculations and modelling have allowed for this and each development type is assessed separately. At this preliminary stage, pervious fractions have been estimated for each development type as set out in the table below.

Table 2 Development Type and Impervious Fractions

Development Type	Estimated Impervious fraction
Residential	0.5
Village Residential	0.7
Mixed Village	0.8
Health Facilities	0.9
Open Space	0
Roads	1
Parking	1
Rehabilitation	0

Where the development zones have impervious fractions that are not zero, the time of concentration has been taken as 5 minutes.

For all the stages, the remainder of the area (not subject to development, and classified as General Open Space) has not been included in the calculations. Existing runoff rates from these areas will not be affected following development, and provision has not therefore been made for treatment or attenuation.

Table 3 provides a summary of these calculations. The calculations are conservative by nature, given that impervious areas have been overestimated, and that rainwater tanks have not been accounted for.

The table includes the detention volume required to successfully mitigate against increases in the rate of runoff.

2.3 Existing and Developed Case Results

Any increase in impervious area following development could result in an increase in the rate of stormwater runoff, and the detention of peak storm flows is therefore required to ensure hydraulic conditions downstream of the proposed site remain as similar to the existing situation as possible.

The detention parameters required for the catchment are outlined in Table 2. The preliminary sizing of the detention basin was carried out according to the methodology outlined in QUDM (refer Section 6.06.1, QUDM). As a conservative approach, the required detention volume was determined by adopting the largest volume derived from each of the formulae discussed in QUDM.

Table 3 Rational Method Results Summary

Stage	Peak Flow Q_{100} (m^3/s)		Detention Requirement		
	Existing Case	Developed Case	Volume (m^3)	Approx Surface Area (m^2)	Assumed Depth (m)
1	3.94	7.77	3050	7750	0.42
2	1.79	3.41	2600	3250	1
3	2.35	4.57	3550	4320	1

The waterbodies located in Stage 1 have an area of approximately 7750m^2 in total. If used to attenuate stormwater during the 100-year event, standing water levels in the ponds would rise by just over 400mm.

Stages 2 and 3 would require dedicated detention basins of the dimensions shown, as they lie below the level of the waterbody contained within Stage 1. The detention volume quoted features a factor of safety of two to account for side slopes and other losses. This does not apply for the waterbodies described above, as they are existing features and only the increase in depth is of interest.

It is expected that a more rigorous assessment of detention dimensions and associated conveyance routes will be carried out during detailed design to confirm that no increase in peak discharge from the site occurs for all events up to and including the 100 year event.

3. STORMWATER QUALITY

3.1 Stormwater Management Practices

A wide range of stormwater management practices is available to achieve the principles of Water Sensitive Urban Design. All have been shown to be successful when correctly designed, but selection of the most appropriate practices for a particular development is highly dependent on site conditions.

Table 4 lists the most common stormwater management practices currently used, along with opportunities and constraints for their use. This table forms the starting point for stormwater management for the site. Considering the site's constraints, not all of the measures outlined in Table 4 are suitable. Each treatment option is therefore discussed in more detail and comment made on the suitability of each in the context of the development.

Table 4 Stormwater Management Practices

Practice	Opportunities			Constraints
	Pollutants removed	Scale	Other	
Litter baskets/racks	Litter and debris – M	Local	Pre-treatment for other practices	Require frequent maintenance
Sediment traps	Coarse sediment – H Suspended solids – L	Regional		Aesthetic and safety issues
Gross pollutant traps (GPTs)	Litter and debris – M Coarse sediment – H Suspended solids – L	Regional	Pre-treatment for other practices	Require regular maintenance
Filter strips/ buffer strips	Litter and debris – M Coarse sediment – H Suspended solids – H Nutrients – M	Lot/Local	Peak flow management	Require flat terrain
Grass swales	Litter and debris – M Coarse sediment – H Suspended solids – H Nutrients – M	Local	Peak flow management	Require flat terrain
Vegetated swales	Litter and debris – M Coarse sediment – H Suspended solids – H Nutrients – H	Local	Peak flow management	Require flat terrain
Extended detention basins	Coarse sediment – M Suspended solids – M Nutrients – L	Regional	Peak flow management	Requires pre-treatment Large land area required
Infiltration trenches	Suspended solids – H Nutrients – M	Local	Peak flow management	Requires pre-treatment
Bioretention systems (rain garden)	Coarse sediment – H Suspended solids – H Nutrients – H	Local	Peak flow management	Requires pre-treatment
Porous pavements	Suspended solids – H Total phosphorus – M Total nitrogen – L	Local	Peak flow management	Not appropriate for steep sites
Constructed wetlands	Coarse sediment – H Suspended solids – H Total phosphorus – M Total nitrogen – L	Regional	Peak flow management	Requires pre-treatment Not appropriate for steep sites Requires large area of land
Rainwater tanks	N/A	Lot	Peak flow management	Requires community involvement
Community education	Litter and debris – L Nutrients – L	Regional	Other benefits include weed control, reduced water use	Community participation

Note: Data taken from NSW EPA Managing Urban Stormwater – Treatment Techniques, 1997
L – 10 – 50% removal
M – 50 – 75% removal
H – 75 – 100% removal
Scales Lot less than 1 ha
Local 1 – 10 ha
Regional greater than 10 ha

3.2 Outline Suitability Assessment

Each of the techniques described is Table 4 is further assessed below, with regard to the site's specific opportunities and constraints.

Litter Baskets/racks

The primary purpose for litter baskets is to remove medium sized litter and debris from the site. Significant litter loads are not expected and other measures will be more appropriate for managing the removal of litter from the site.

Sediment Traps

Sediment traps will be required during the construction phase to limit the transport of sediment off site. Following construction, sediment levels will return to a low level, and traps are therefore not considered necessary as a long-term water quality measure.

Gross Pollutant Traps

Gross pollutant traps (GPTs) are predominantly used for the removal of litter and debris – although they have been shown to effectively remove coarse sediment and suspended solids (Brisbane City Council, 1999). GPTs will be placed before bioretention basins to reduce pollutant loads and prolong filter life.

Filter Strips/Buffer Strips

Buffer strips are areas of land left in their natural state that act to reduce peak runoff flows and improve the quality of stormwater runoff. Buffer strips are considered to be a valuable component of the stormwater management system for this development. This treatment improves the aesthetic and biodiversity value of the development and provides significant quality and quantity improvements.

Grass Swales

Grass swales are considered a highly effective and aesthetic water quality (and to a lesser extent, water quantity) control measure, when placed in flat areas. In this case, vegetated swales, described below, are more appropriate.

Vegetated Swales

Vegetated swales require similar conditions as those outlined for grass swales above. Space is limited in the commercial development, but car park dividing features and edges could be utilised, both for aesthetic purposes and to serve a water quality function. The road areas will be drained towards them, and they will incorporate a filter bed and conveyance system. Their usefulness increases when combined with a filter (see 'Bioretention Systems').

Extended Detention Basin

Extended detention basins are designed to generally store runoff for 1-2 days. Their main purpose is the reduction of the peak discharge from the site during a storm event, and the retention of particulate matter.

Infiltration Trenches

Infiltration trenches allow pre-treated stormwater runoff to infiltrate to into surrounding soils and groundwater, and as such are not a treatment device in themselves. Where space is limited, bioretention systems are preferred.

Bioretention Systems

Bioretention systems effectively combine a grass or vegetated swale with an infiltration trench. They are considered to be extremely effective in removing sediment and nutrients. Although they require a flat area, they can be incorporated in steeper areas using a stepped system. They can also be located within a detention basin, thereby combining the stormwater quality and quantity functions into a smaller area. Bioretention systems are considered appropriate for all development stages. Bioretention processes will also occur in the filters installed beneath the swales serving the road areas.

Porous Pavements

Porous pavements are not appropriate for high traffic areas due to increased maintenance requirements. They are also less effective in steep areas.

Constructed Wetlands

Wetlands require reasonably large flat areas of land. Such an area exists in Stage 1. This will be utilised as an attenuation facility, but flows will be treated to a suitable degree before entry to the waterbody to prevent litter nuisance, nutrient build-up and possible eutrophication.

Rainwater Tanks

The ability exists to install rainwater tanks throughout the development to reduce overall water consumption, and where space permits tanks with significant storage volumes could be utilised.

Tanks are an extremely useful aid to water conservation, and also have some effect in reducing nitrogen levels. The capacity of the tanks has been discounted in stormwater runoff calculations however, as although they can have a considerable effect in reducing runoff volumes, they cannot be assumed to be empty when needed.

3.3 Proposed Stormwater Management

In summary, the stormwater management practices considered appropriate for use in this development are:

- gross pollutant traps on roadways and to intercept flows to bioretention basins;
- vegetated swales to collect runoff from roads, incorporating bioretention systems in their base for the removal of sediment and attached nutrients;
- rainwater tanks for the collection and reuse of roof runoff;
- buffer strips to intercept impervious areas on residential lots;
- infiltration systems for the Village Green and Oval;
- bioretention basins for all stages; and,
- existing waterbodies in Stage 1 for final polishing (also serving as attenuation devices).

To ensure that the Water Quality Objectives (described in the following section) can be met, devices will be sized such that all stormwater up to the three-month design flow will have passed through the nominated measures for treatment.

4. WATER QUALITY MODELLING

4.1 Site Specific Objectives

Water Quality Objectives (WQO) for the study site have been derived from the *Tweed Urban Stormwater Quality Management Plan*. Council has developed interim water quality objectives following the advice given in the ANZECC Water Quality Guidelines for Fresh and Marine Waters (1992), and an assessment of similar watercourses in the region. These interim water quality objectives, adopted by Council in 1998, are presented in Table 5 below.

Table 5 Tweed Shire Council Interim Water Quality Objectives

Parameter	Units	Freshwater segments
PH	pH units	6.5-9
Dissolved Oxygen	mg/L	>6
Suspended Solids	mg/L	<20
Total Phosphorus	mg/L	<0.10
Total Nitrogen	mg/L	<0.75
Chlorophyll a	mg/L	<10
Faecal Coliforms	No./100mL	<150

Tweed Shire Council recognises that background water quality levels are difficult to assess due to natural variations in aquatic systems, and also that the guideline concentrations relate to in-stream values rather than the quality of water discharged from land.

In order to overcome this, Council has developed further objectives for the Post Construction or Occupational Phase of Development. Using a mix of water sensitive subdivision and development project design, source controls and end of pipe solutions, the following objectives should be achieved in the long term:

Table 6 Stormwater Treatment Objectives for Post Construction Phase of Development

Pollutant	Average Year (1719mm)	Wet Year (2185m)	Dry Year (929mm)
	Maximum permissible load, kg/ha/year		
Suspended Solids	300	400	120
Total Phosphorus	0.8	1.1	0.35
Total Nitrogen	4.5	6	1.5
Litter	Retention of 70% of annual load greater than 5mm		
Coarse Sediment	Retention of 90% of annual load of sediment coarser than 0.125mm		
Oil and Grease	<10mg/litre in flows up to 40% of Q1 peak		

Of all the above parameters, only the detailed modeling of suspended solids and nutrients (nitrogen and phosphorus) is possible at present using the industry standard analysis package (MUSIC), due to the lack of information regarding export rates. The modelling of defined water quality objectives has therefore necessarily focused on these parameters. For the remaining water quality indicators, it is necessary to consider the likely efficiency of the proposed treatment measures.

Based on the average removal efficiencies predicted in Table C4.3 of the Brisbane City Council *Water Quality Management Guidelines* (2000), the likely removal efficiency of the proposed treatment measures is as follows:

- Litter 83 percent removal
- Heavy Metals 77 percent removal

These rates of removal will be sufficient to provide an appropriate level of treatment to runoff. With respect to faecal coliforms, it is expected that the exposure to sunlight and filtration afforded by the bioretention systems will provide a sufficient reduction in faecal coliform concentrations.

With respect to dissolved oxygen, it is expected that runoff will not contain significant concentrations of oxygen demanding substances. In any case, the drainage of the majority of runoff from the site will take the form of slow release from the base of the infiltration areas to be used for the bioretention systems. The discharge of the slow flow will allow ample opportunity for aeration.

As well as achieving the maximum permissible loads set out in Table 6, the development will be designed in accordance with the guidance set out in Tweed Shire Council's *Development Design Specification D7: Stormwater Quality* (particularly at the detailed design stage, when sizing constructed wetlands, for example). In addition, two alternative and accepted benchmarks have been examined and expressed in this report. The first is to ensure that the overall annual pollutant load is not increased following development. The second is to ensure that minimum treatment train efficiencies are achieved. The results of these three tests are presented in the following sections.

4.2 MUSIC Methodology

In order to determine the effectiveness of the proposed treatment train in meeting these water quality objectives, a stormwater quality analysis was performed using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 3.01. The model requires the user to specify meteorological data (rainfall and evaporation), soil properties and pollutant loads for each catchment, and suitable parameters for the MUSIC model were adopted in accordance with the recommendations of Tweed Shire Council's *Development Design Specification D7: Stormwater Quality* (v1.3, August 2005).

Tweed Shire Council has defined source nodes for urban, rural and undeveloped land use types. Based on these, the existing situation was modelled as 'Rural Tweed' as opposed to 'Undeveloped', as the area has been subject to clearing and grazing. For the proposed development, the three stages were further broken down into individual land use types according to the developer's structure plan (such as residential, mixed village, open space etc). Most were modelled using the 'Developed Tweed' source node, with the exception of Open Space and areas set aside for rehabilitation, which were modelled as 'Rural Tweed'.

Specification D7 gives the percentage impervious area that should be used with each source node. However, these apply when adopting an overall view of a development, but in this case the stages and the development zones within them have been more closely analysed.

Table 2 described the impervious fractions for each development type. However, these applied for runoff calculations, and a refinement was required for the quality modelling process. In order to accurately asses the effects of source controls such as rainwater tanks and buffer strips, it is necessary to separate out roof and lot area within each development type, as is shown in Table 7.

Table 7 Development Type and Impervious Fractions for Quality Modelling

Development Type	Overall Impervious fraction	'roof' fraction, 100% impervious	'lot' fraction, 25% impervious
Residential	0.5	0.33	0.66
Village Residential	0.7	0.5	0.5
Mixed Village	0.8	0.75	0.25
Health Facilities	0.9	0.8	0.2

'Roof' fractions are consistently lower than the overall impervious fractions, because the 'lot' area will also contain impervious areas such as paths, patios and driveways. Each of the above development types was therefore modelled using two nodes: the first being completely impervious and discharging to rainwater tanks of appropriate total size, and the second being 75% pervious and discharging over buffer strips. It can be seen that the new combined impervious fractions are slightly lower than those used in the runoff calculations, providing a conservative assessment of detention requirements.

The three source nodes were downloaded from Council's website, together with the 6-minute rainfall data series for Murwillumbah for 1978 (with a rainfall total of 1693mm, this can be regarded as an 'average' year). Flow-based sub-samples were used to exclude periods of dry flow (<0.1L/s), resulting in modified, more realistic, median results. The runoff generation parameters adopted are listed in Appendix B, together with the pollutant export relationships.

4.3 Conceptual Treatment Train

The site has been divided into three stages, in accordance with the planned development of the site over time. The stages are largely similar in their area and content, and so it is more convenient to describe the proposed treatment measures that have been adopted for each source type:

Residential, Village Residential and Mixed Village Zones:

Roof and lot areas have been regarded separately as described in the previous section. Rainwater tanks are used to intercept the high-quality runoff from roofed areas. Lot areas, or 'green' areas in the case of the Mixed Village zone, are regarded as being 25% impervious. Runoff from these areas is routed through buffer strips.

All runoff from developed areas of the site is then conveyed along shallow vegetated swales to a bioretention basin, protected by an upstream gross pollutant trap (GPT).

Roads and Car Parking Areas

Where the treatment train as a whole is seen to be meeting its objectives, runoff from roads and parking is routed direct to the GPT and onto the bioretention basin. Where particularly large areas of roads or parking are involved, or the system is already stressed, then after passing through dedicated in-situ GPTs, bioretention swales will be employed.

These have been modelled as 100m or 200m long vegetated swales (as necessary) of up to 5m wide, but featuring a sandy loam filter medium of one metre depth beneath. This filter trench could be lined as necessary to protect groundwater quality, and seepage losses have not been included at this stage.

All runoff deriving from roads and car parks is then directed through the bioretention basin, regardless of pre-treatment.

Open spaces

Although assumed to be completely pervious, any runoff that does originate from the landscaped open spaces around the site could be contaminated with fertilisers and such like, and would therefore require treatment. A system has been modelled for each that takes the form of a vegetated margin around the perimeter of the landscaped area, specifically designed to allow infiltration of runoff into the subsoil. The margin would be up to two metres wide and half a metre deep, and if conditions are not already favourable, it would include a subsoil media to allow infiltration at a rate of 36mm/hr.

Runoff from open spaces is routed in the model to the receiving node, and undergoes no further treatment.

Areas for set aside for rehabilitation have been included in the model, but are not subject to water quality treatment measures. Efforts will be made to return these areas to their natural state, and the conservation management measures employed will preclude the use of fertilisers and such like.

4.4 Device Sizing

Rainwater Tanks

Total tank sizes are entered for each development zone, assuming each dwelling utilises a 2400 litre capacity tank. To establish the number of dwellings, Residential zones were divided by an anticipated lot size of 600m^2, Village Residential zones by 400m^2 and Mixed Village zones by 200m^2.

Buffer Strips

Each buffer strip was assumed to treat all of the impervious area it serves, and occupy an area equivalent to 5% of the buffered area. A seepage loss of 36mm/hr has been assumed.

Vegetated Swales

The exact dimensions and capacity of the conveyance channels will be determined at the detailed design stage. For the moment, they have been assumed to be 0.75m deep and approximately 10m wide at their widest and 2m at their base.

Gross Pollutant Traps

Standard practice is to size GPTs to treat runoff from the 3-month event, which is taken to have a magnitude equal to 40% of the one-year event. As part of the detailed design, gross pollutant traps (such as Ecosol or Humeceptor units) will be sized for the site. The traps have been modelled as removing 40 percent of suspended solids, and 20 percent of the phosphorus and nitrogen loads, in accordance with Brisbane City Council guidelines (2000).

Bioretention Devices

As noted in Section 3.2, bioretention devices consist of a vegetated storage area over a filter media. Ponding in the vegetated storage area allows the settlement of sediment and the uptake of nutrients. Sediment and nutrient removal is enhanced by the stored runoff draining through a filter media in the base of the storage area.

It is desirable to limit the rate at which water drains from the system to maximise performance. For this reason, the plan area of the filter media is typically less than the surface area of the storage.

The following parameters have been adopted:

Table 8 Bioretention Device Parameters

Parameter	*1*	*2*	*3*
Surface Area (m^2)	7500	3500	4800
Filter Area (m^2)	1000	200	250
Extended Detention Depth (m)	1	1	1
Seepage Loss (mm/hr)	0	0	0
Filter depth (m)	0.5	0.5	0.5
Filter type	Sandy loam	Sandy loam	Sandy loam
Filter median particle diameter (mm)	0.45	0.45	0.45
Saturated hydraulic conductivity (mm/hr)	180	180	180
Depth below underdrain pipe (%)	0	0	0
Overflow weir (m)	2	2	2

In order for the bioretention system to work effectively, it must be installed correctly and properly maintained. If installed correctly, maintenance of the system will be minimal and infrequent.

The planting soil shall be a uniform mix, free from large objects (greater than 50mm in diameter). No materials which may be harmful to plant growth shall be mixed with the soil within the infiltration trench. The infiltration trench soil shall be free of all declared plants as specified under the Rural Lands Protection Act (1985).

Planting within the bioretention trench area shall consist of Lomandra Longifolia (long stemmed matrush) or Lomandra Hystrix (Matrush) planted at a spacing of 1 metre between stems. The area outside the bioretention trench (and within the bioretention area) can be grassed or provided with an alternate landscape treatment.

4.5 Modelling Results

A MUSIC model was developed that first examined the existing situation, as nutrients would be expected in runoff deriving from undeveloped areas. A simulation was then made of the effect of the proposed development, but without Water Sensitive Urban Design techniques. Finally, the performance of the sustainable drainage systems described in the previous section was assessed.

The results produced by the model are reported in Table 9 below.

Table 9 Total Annual Loads, Existing and Proposed

Zone	Total Suspended Solids (kg/yr)		Total Phosphorus (kg/yr)		Total Nitrogen (kg/yr)	
	existing	proposed	existing	Proposed	existing	Proposed
1	5410	763	13.5	7.64	81.0	71.4
2	2750	454	7.08	3.29	42.6	37
3	5280	1020	13.8	4.98	83.7	53.0
Total	**13440**	**2237**	**34.38**	**15.91**	**207.3**	**161.4**

As would be expected, development has the potential to increase suspended solids and nutrient levels in runoff from the site. However, it can be seen that the application of the proposed drainage designs would reduce all of the total loads released from the developed site compared to the existing.

In accordance with Tweed Shire Council's objectives, the above total values have been examined in terms of developed area, to give amounts in kilograms per hectare per year. Table 10 below shows the results compared to the maximum permissible loads that may be discharged.

Table 10 Pollutant Loads per Hectare per Year

Zone	Stage area (hectares, not including general open space)	Total Suspended Solids (kg/ha/yr)	Total Phosphorus (kg/ha/yr)	Total Nitrogen (kg/ha/yr)
1	12.6	60.6	0.47	5.67
2	5.73	79.2	0.57	6.45
3	7.53	135	0.66	7.04
Target		**300**	**0.8**	**4.5**

It can be seen that in all cases for suspended solids and phosphorus, the discharges from the site are lower than the permissible values, and for nitrogen the values are of a similar order. However, the site includes areas classified as General Open Space, and as these will be left largely in their original state, have not been included in the modelling in accordance with the conservative approach.

If included, the total Stage areas increase to 16.3, 8.5 and 16.8 hectares respectively. This is a better indication of the low overall density of the development, and reduces the total pollutant loads per hectare per year by around one third.

Finally, the performance of the treatment train can also be assessed by examining its removal efficiency. Brisbane City Council, for example, has set removal efficiency

targets, and it can be seen from Table 11 below that these have been achieved in all cases.

Table 11 MUSIC Removal Efficiencies (%)

	Suspended Solids	Total Phosphorus	Total Nitrogen
1	95.3	85.2	70.6
2	93.0	79.1	61.9
3	88.8	78.0	61.2
SITE TOTAL (area weighted)	**92.9**	**81.8**	**65.9**
Target	**80**	**60**	**45**

4.6 Construction Phase Sediment Control

During the construction phase, the potential exists for significant increases in the amount of pollutants, particularly sediment, exported from the site. During this period, an Erosion and Sediment Control Plan is required as part of the overall Environmental Management Plan prepared for the construction phase.

The erosion and sediment control plan for the site would be completed in accordance with *Soil Erosion and Sediment Control, Engineering Guidelines for Queensland Construction Sites* (Institution of Engineers Australia, 1996). The completion of construction activities in accordance with the above guidelines will minimise the nature of any adverse impacts during the construction phase.

It is considered that the appropriate time for the preparation of the Erosion and Sediment Control Plan is at the Operational works stage. Further, it is expected that the requirement to prepare a plan will be a condition of any development approval issued with respect to the site.

The performance criteria applicable to the development during the construction phase are listed in Tweed Shire Council's Urban Stormwater Quality Management plan, as follows:

- Minimise soil erosion and exposure
- Minimise transportation of eroded soil by air and water
- Limit suspended solids concentration in stormwater to not more than 50mg/L
- Limit/minimise the amount of site disturbance
- Isolate the site by diverting clean upstream 'run on' water around the development
- Control runoff and sediment at its point source rather than at final point
- Stage ground disturbance/earthworks and progressively revegetate the site where possible to reduce the area contributing sediment
- Retain topsoil for revegetation works
- Locate sediment control structures where they are most effective and efficient

These objectives will be achieved in accordance with '*Tweed Shire Council, Aus Spec D7 – Stormwater Quality* and Annexure A – Code of Practice for Soil and Water

Management on Construction Works'. Should there be non-compliance with the performance indicators prepared as part of the overall EMP for the construction phase, the following corrective actions are to be implemented.

- Identification of the cause of the non-compliance;
- Implementation of appropriate mitigation measures as determined by the Contractor in consultation with the Consultant; and
- Relevant validation monitoring to confirm that the nominated corrective actions have been effective.

It is envisaged that the bioretention systems will first be constructed as sediment basins to treat runoff during the construction phase. At the end of construction, the basins would have any accumulated sediment removed and the bioretention filter and vegetation installed. As there is likely to be a significant sediment load generated as houses are built on lots following the completion of subdivision works, it may be necessary to replace the filter media at intervals until the catchment is fully established.

4.7 Ongoing Maintenance

The proposed maintenance for the bioretention systems is drawn from the Melbourne Water publication *WSUD Engineering Procedures: Stormwater* (June 2004, Chapter 6, p21):

"The most intensive period of maintenance is during the plant establishment period (first two years) when weed removal and replanting may be required. It is also the time when large loads of sediments could impact on plant growth particularly in developing catchments with poor building controls.

Maintenance is primarily concerned with:

- *Maintenance of flow to and through the bioretention basin*
- *Maintaining vegetation*
- *Preventing undesired overgrowth vegetation from taking over the bioretention basin*
- *Removal of accumulated sediments*
- *Litter and debris removal*

Vegetation maintenance will include:

- *Fertilising plants*
- *Removal of noxious plants or weeds*
- *Re-establishment of plants that die.*

Sediment accumulation at the inlets needs to be monitored. Depending on the catchment activities (eg building phase) the deposition of sediment can tend to smother plants and reduce the ponding volume available. Should excessive sediment build up it will impact on plant health and require removal before it reduces the infiltration rate of the filter media.

Similar to other types of practices, debris removal is an ongoing maintenance function. Debris, if not remove, can block inlets or outlets, and can be unsightly if located in a visible location. Inspection and removal of debris should be done regularly, but debris should be removed whenever observed on the site."

Given the above, a three monthly inspection frequency is proposed until the catchment has become stabilised (i.e. buildings within the development are largely complete). After this time, the frequency of inspections can be reduced to every six months or as determined by the operational performance of the devices. A more formal monitoring and maintenance program will be produced as part of detailed design.

5. CONCLUSION

Peter Van Lieshout plans to develop an area of land on Kyogle Road in the Kunghur area of north-eastern New South Wales to create a residential village. To ensure that water quality is maintained following development, water sensitive urban design measures have been employed around the site to treat runoff at source.

The proposed development has been divided into three stages, all containing several zones of various development type and density. In order to protect the water quality of the River Tweed, flowing through the south of the site, a treatment train of water sensitive urban drainage measures has been formulated for each.

The techniques employed include rainwater tanks, buffer strips, infiltration systems, vegetated swales, gross pollutant traps and bioretention basins; all of which will be subject to detailed design at a later stage in accordance with the guidance available from Tweed Shire Council (Development Design Specification D7).

The proposed site and its outline treatment systems have been modelled using the industry-standard software, MUSIC 3.01. The modelling has demonstrated that development can proceed without adverse effect on the local environment.

Firstly, concentrations of pollutants discharged from the site are lower than the interim water quality objectives defined by council. Secondly, the total annual load of pollutants following development will be lower than the existing situation. Thirdly, the total pollutant load, when expressed as an annual discharge per hectare, meets or closely approaches permissible limits set by Council. Lastly, the overall efficiency of each treatment train achieves the accepted removal targets.

In order to prevent or exacerbate flooding downstream, the rate of runoff from the site following development has also been addressed. Through a combination of existing and proposed detention basins, and the storage capacity inherent in the proposed bioretention basins, it has been shown that runoff rates following development will resemble those of the existing situation.

FIGURES

Figure 1 **Schematic Treatment Train (Stage 1)**

Figure 2 **Schematic Treatment Train (Stage 2)**

Figure 3 **Schematic Treatment Train (Stage 3)**

Figure 4 **Conceptual Stormwater Drainage System**

Figure One: Schematic Treatment Train (Stage 1)

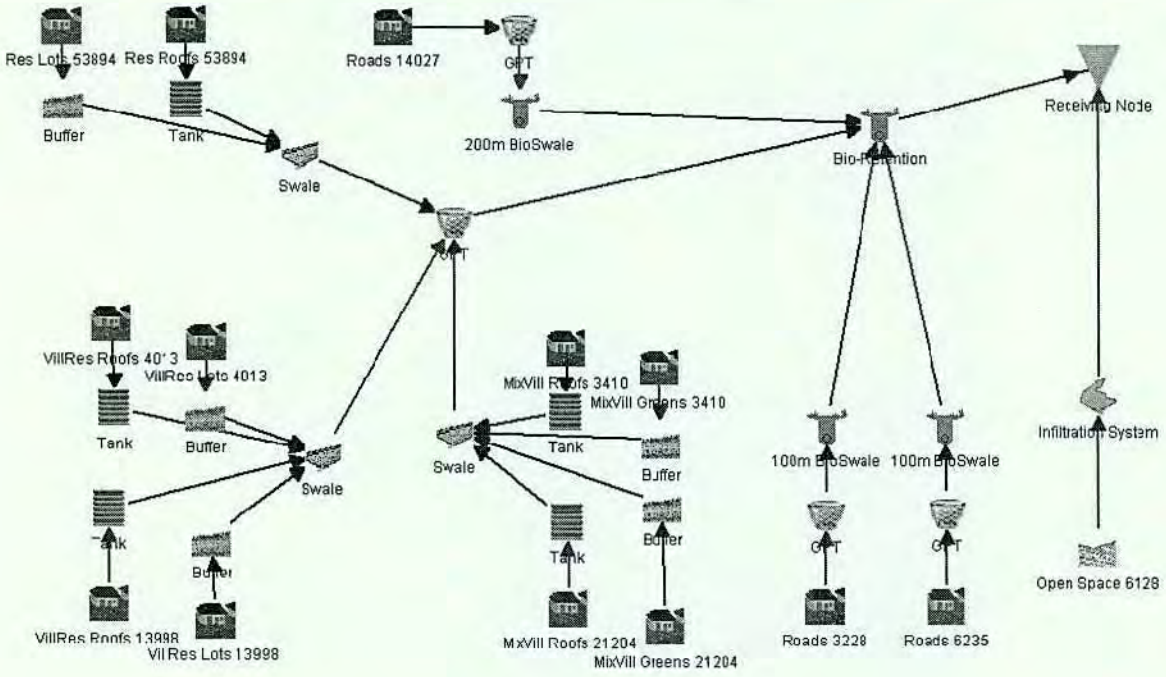


Figure Two: Schematic Treatment Train (Stage 2)

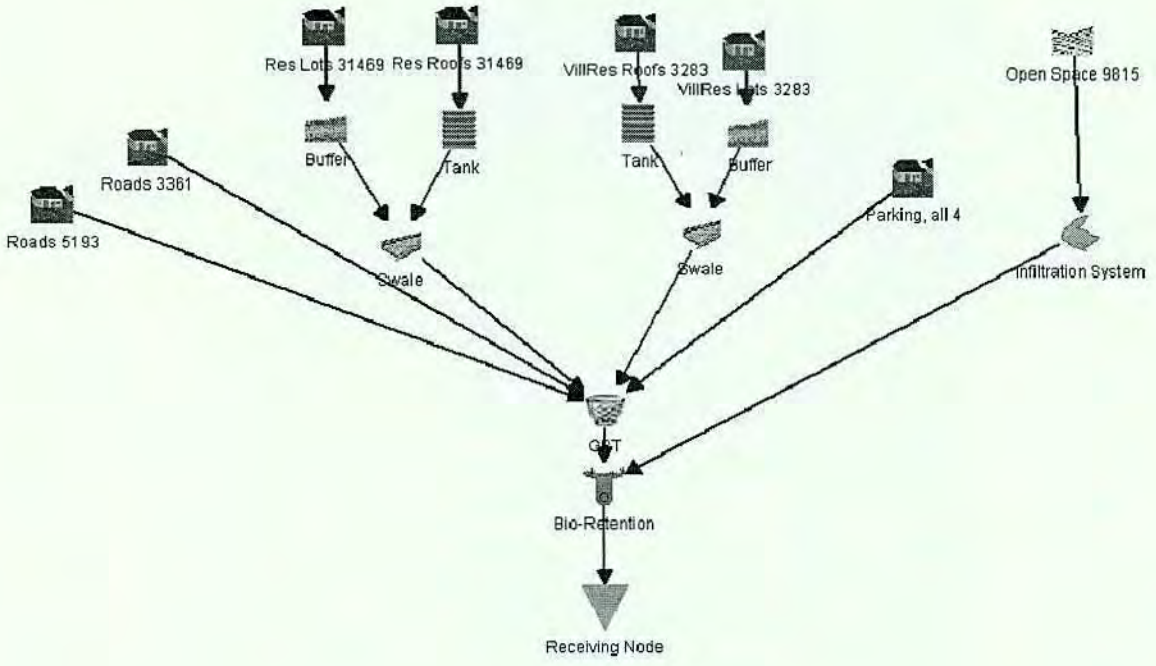
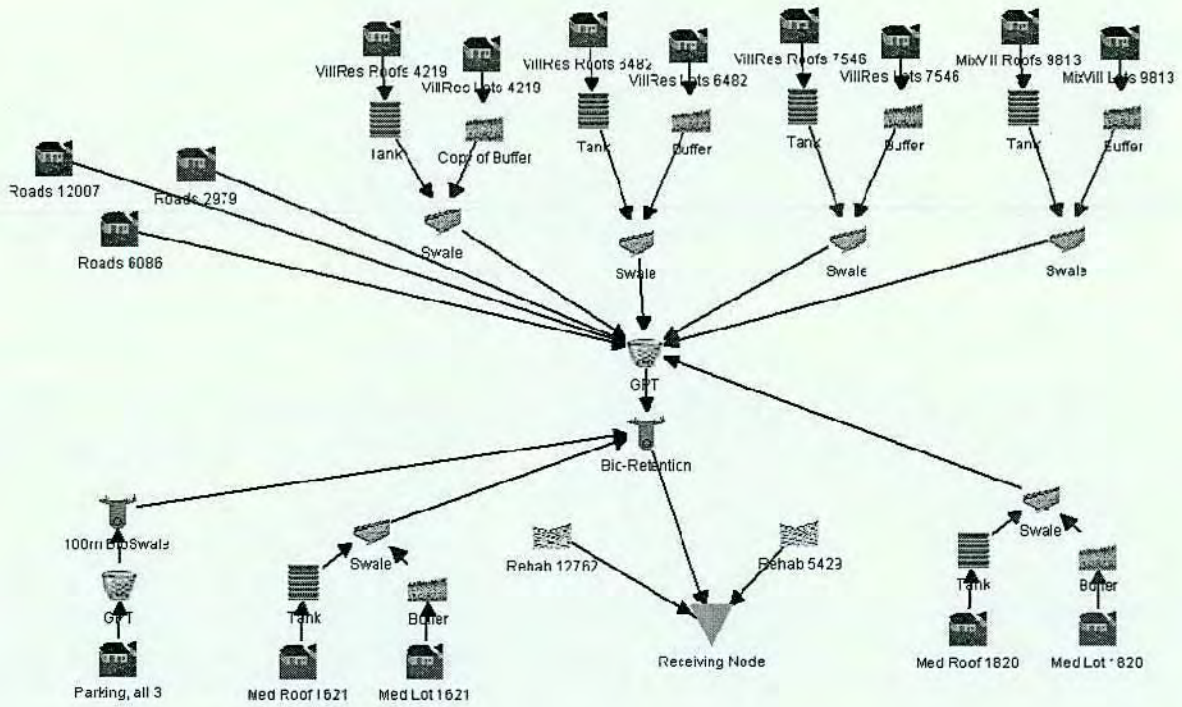
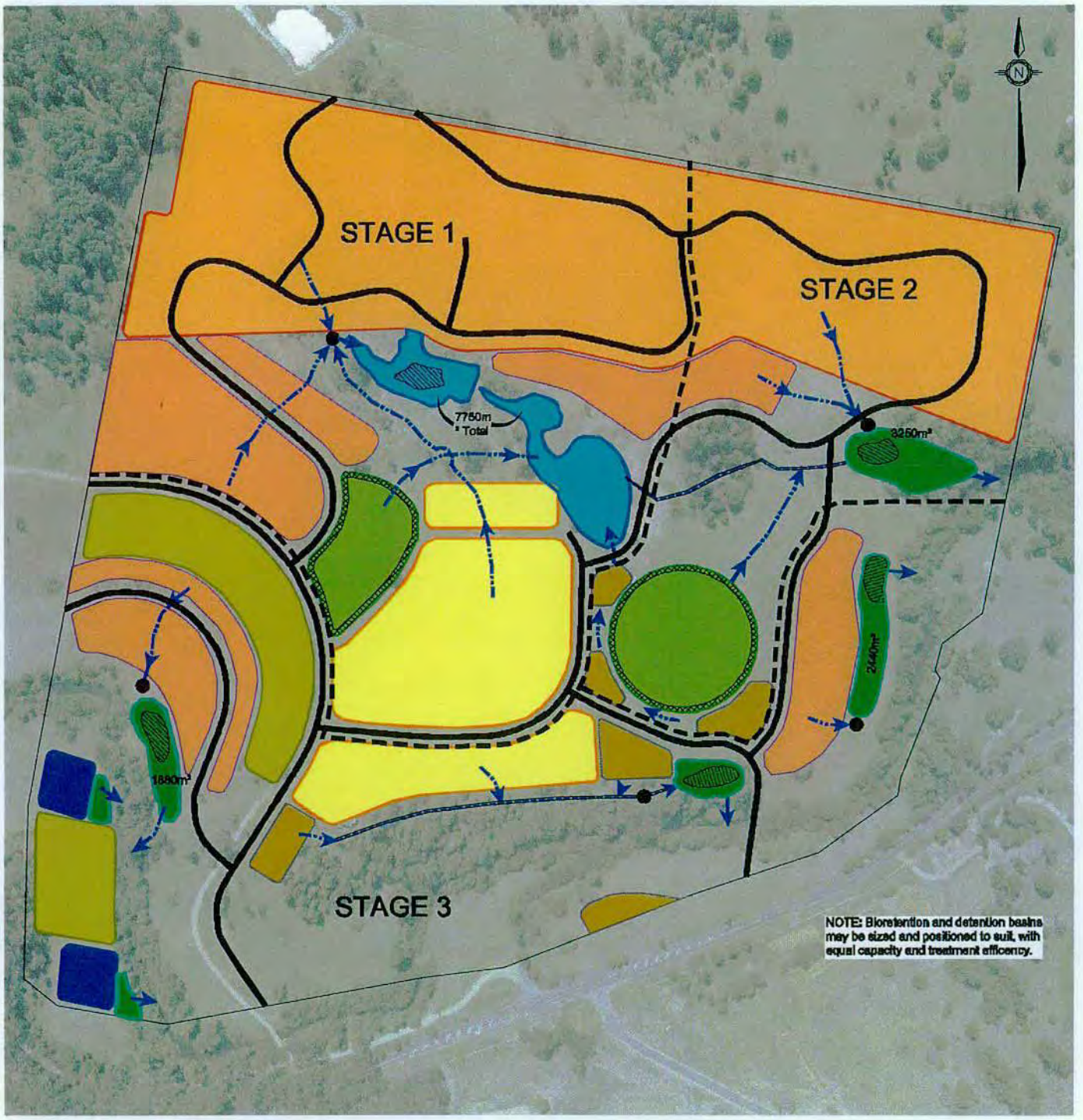


Figure Three: Schematic Treatment Train (Stage 3)





STRUCTURE PLAN

- Residential
- Mixed Village
- Car Parking
- Proposed Treatment Devices
- Open Space
- Tourism/Special Use
- Rehabilitation Areas
- Conveyance Channel/Swale

LEGEND

- GPT
- Infiltration System
- Bioretention Filter
- Staging Boundary

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Rev: A Date: 30 June 2006
Peter Van Lieshout

Scale 1:3000 (A3)

FIGURE 4

CONCEPTUAL STORMWATER DRAINAGE SYSTEM

Project No.: 3500/53

APPENDIX A

Music Parameters

Runoff Generation Parameters

Parameter	Urban Tweed	Rural Tweed	Undeveloped Tweed
Field Capacity (mm)	50	50	50
Infiltration Capacity Coefficient a	50	50	50
Infiltration Capacity Exponent b	2	2	2
Rainfall Threshold (mm)	1	1	1
Soil Capacity (mm)	150	150	150
Initial Storage (%)	25	25	25
Daily Recharge Rate (%)	0.65	0.65	0.65
Daily Drainage Rate (%)	.85	0.85	0.85
Initial Depth (mm)	50	50	50

Pollutant Export Relationships

Land Use Source Nodes	Parameter	Total Suspended Solids (mg/L)		Total Phosphorus (mg/L)		Total Nitrogen (mg/L)	
		Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow
Urban Tweed	Mean	0.800	2.000	-1.000	-0.680	-0.100	0.193
	Std Dev.	0.200	0.145	0.340	0.280	0.050	0.050
Rural Tweed	Mean	0.600	1.627	-1.400	-0.950	-0.150	-0.250
	Std Dev.	0.200	0.200	0.400	0.100	0.400	0.197
Undeveloped Tweed	Mean	0.800	1.200	-1.000	-1.470	-0.100	-0.900
	Std Dev.	0.200	0.145	0.340	0.300	0.050	0.100

9. CULTURAL HERITAGE SEARCH

Davies Heritage Consultants - 2006

DAVIES HERITAGE CONSULTANTS PTY LTD
PO Box 208, RED HILL, Qld 4059
ACN [illegible]

FASCIMILE COVER SHEET

FAX TO: Liz Clough

COMPANY: Cardno (Qld) Pty Ltd

FAX No.: (07) 3369 9722

DATE: 3/7/06

No OF PAGES (INCL. COVER): 4

SUBJECT: Re: AHIMS Search - Uki

Message:

Copy of results of site search for Uki following.

Regards

Su Davies

Department of
Environment and Conservation (NSW)

[redacted]

Your reference : Brays Creek
Our reference : AHIMS #16168

Davies Heritage Consultants Pty Ltd
Po Box 208
Redhill QLD 4059

Wednesday, 28 June 2006

Attention: Su Davies

Dear Sir or Madam:

Re: AHIMS Search for the following area at Brays Creek;Z:56;E: 320000-325000;N:6846000-6853000

I am writing in response to your recent inquiry in respect to Aboriginal objects and Aboriginal places registered with the NSW Department of Environment and Conservation (DEC) at the above location.

A search of the DEC Aboriginal Heritage Information Management System (AHIMS) has shown that *0* Aboriginal objects and Aboriginal places are recorded in or near the above location. Please refer to the attached report for details.

The Information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not to be made available to the public.

The following qualifications apply to an AHIMS search:

- AHIMS only includes information on Aboriginal objects and Aboriginal places that have been provided to DEC;
- Large areas of New South Wales have not been the subject of systematic survey or recording of Aboriginal history. These areas may contain Aboriginal objects and other heritage values which are not recorded on AHIMS;
- Recordings are provided from a variety of sources and may be variable in their accuracy. When an AHIMS search identifies Aboriginal objects in or near the area it is recommended that the exact location of the Aboriginal object be determined by re-location on the ground; and
- The criteria used to search AHIMS are derived from the information provided by the client and DEC assumes that this information is accurate.

All Aboriginal places and Aboriginal objects are protected under the *National Parks and Wildlife Act 1974* (NPW Act) and it is an offence to destroy, damage or deface them without the prior consent of the DEC Director-General. An Aboriginal object is considered to be known if:

PO Box 1967 Hurstville NSW 2220
45 Bridge Street Hurstville NSW 2220

Telephone (02) 9585 6345
Facsimile (02) 9585 6094

ABN 30 841 387 271
ahimsadmin@environment.nsw.gov.au
www.environment.nsw.gov.au

- It is registered on AHIMS;
- It is known to the Aboriginal community; or
- It is located during an investigation of the area conducted for a development application.

If you considering undertaking a development activity in the area subject to the AHIMS search, DEC would recommend that an Aboriginal Heritage Assessment be undertaken. You should consult with the relevant consent authority to determine the necessary assessment to accompany your development application.

Yours Sincerely

Freeburn, Sharlene
Administrator
Information Systems Section
Cultural Heritage Division
Phone: (02) 9585 6471
Fax: (02) 9585 6094

AHIMS Australian Heritage Information Management System

Department of Environment & Conservation

List of Sites (List - Short)

Brays Creek

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 328000, Easting to = 329000, Northing From = 6346000, Northing to = 6353000, Requestor Ike 1779%, Service ID = 18188, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Site Features	Site Types (recorded prior to June 2008)	Recorders (Primary)	Reports (Catalogue Number)

No Site Recorded

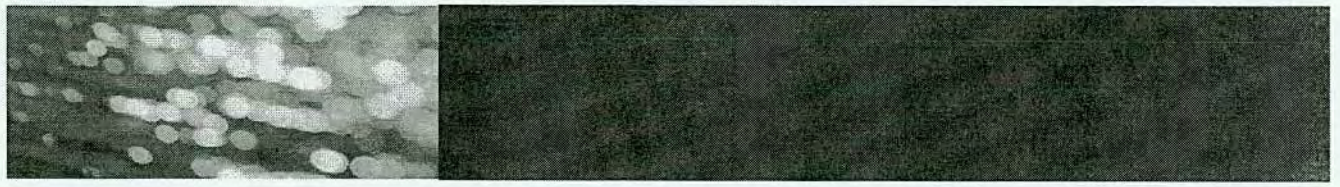
Number of Sites : 0

28/06/2008 11:08:25

10. NIGHTCAP VILLAGE ENVIRONMENTAL MANAGEMENT PLAN

Cardno - 2006

Cardno
Engineering the Future



Nightcap Urban Village

Environmental Management Plan

21 July 2006
Job No. 3500/53

Peter Van Lieshout

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Document Control

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		Name	Initials	Name	Initials
1	17 March 2006	L Clough/A Caldwell	LC/AC	C Sutcliffe	CS
2	21 April 2006	L. Clough/A Caldwell	LC/AC	C Sutcliffe	CS
3	28 June 2006	L. Clough	LC	C. Sutcliffe	CS
4	21 July 2006	L. Clough	LC	C. Sutcliffe	CS

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NIGHTCAP URBAN VILLAGE
ENVIRONMENTAL MANAGEMENT PLAN

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Figure 3 Constraints Plan

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APPENDIX A Corrective Action Request Form
APPENDIX B Waste Register Forms

EXECUTIVE SUMMARY

This Environmental Management Plan (EMP) has been prepared on behalf of Peter Van Lieshout for submission with an application for development of Lot 3 on DP771335 and Lot 121 on DP134446 located on the Uki-Kyogle Road, Kunghur, New South Wales.

Site investigations were undertaken to determine opportunities and constraints of development. This EMP provides management measures to mitigate potential impacts identified during site investigations including air quality and noise control measures, water quality and sediment and erosion control and waste minimisation and management.

An Ecological Assessment was undertaken to identify significant flora and fauna communities pursuant to the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994*, *Rivers and Foreshores Improvement Act 1948* and the *State Environment Planning Policy – Koala Habitat Protection*. Protection of significant flora and fauna pursuant to this legislation will be provided by management measures proposed within this EMP.

This EMP was developed to ensure compliance with the requirements of the *Environmental Planning and Assessment Act 1979* and the provisions of the *Tweed Local Environment Plan 2000* and the *Tweed Shire Council Development Control Plan No. 16 Subdivision Manual*.

1. INTRODUCTION

This Environmental Management Plan (EMP) provides environmental management requirements for construction of the Nightcap Urban Village at 2954 Kyogle Road, Khungur New South Wales. The site is located 12km southwest of Uki in the Nightcap Ranges and comprises Lot 3 on DP771335 and Lot 121 on DP134446. A Site Locality Plan is presented as Figure 1. The site is predominantly cleared with existing riparian vegetation associated with the Tweed River, which traverses the site in the south.

The proposed development will involve construction of urban residential and village residential lots including medium density and high density residential precincts. A mixed use precinct will be established in the centre of the site and commercial and health facilities will also be provided. Open space areas will include sports fields, a market garden and village green and environmental open space areas along the Tweed River. The proposed plan of development is presented as Figure 2.

Riparian vegetation and isolated vegetation stands will be retained within the development. Rehabilitation of degraded vegetation in riparian areas of the Tweed River will be undertaken to improve site ecological values and enhance amenity of open space areas.

This EMP has been prepared to manage the potential environmental impacts that may occur as a result of site development. The EMP outlines environmental controls to be implemented during the construction and operation phases of development. The following key elements are addressed in this EMP.

- Flora and Fauna Management.
- Water Quality Management.
- Sediment and Erosion Control.
- Air Quality Control.
- Noise Emissions Control.
- Waste Minimisation.
- Contingency Plan

2. PREAMBLE TO THE ENVIRONMENTAL MANAGEMENT PLAN

2.1 EMP Structure

The EMP includes the following components for each of the key environmental elements.

- **Rationale:** identification of the element to be managed and the potential environmental impact of activities associated with each element.
- **Objectives:** identification of the environmental objectives and targets to be achieved in line with the rationale and in compliance with applicable legislation.
- **Tasks/Actions:** monitoring and management measures to be implemented in order to achieve the stated objectives and targets and to ensure impact mitigation.
- **Performance Indicators:** measurable indicators and standards set to assess the efficiency of management measures and determine compliance with the Construction EMP.
- **Monitoring:** monitoring requirements to measure compliance with the performance indicators and frequency of monitoring.
- **Reporting and Review:** the requirements for reporting of monitoring results and review of management measures where required.
- **Corrective Action:** measures to be undertaken should monitoring indicate non-compliance with performance indicators.

2.2 Terminology

The term **Developer** refers to Peter Van Lieshout.

The term **Contractor** refers to the party or company contracted to perform construction works relating to the proposed development and includes all employees of the Contractor and sub-contractors.

The term **Consultant** refers to the civil and/or environmental engineering consultant employed by the Developer.

The term **Works** refers to all matters associated with the construction of the proposed development.

The term **Council** refers to Tweed Shire Council.

The term **NSW EPA** refers to the New South Wales Environmental Protection Authority (Department of Environment & Conservation).

The term **EMP** refers to the Environmental Management Plan.

2.3 Responsibility and Contractual Obligations

This EMP covers the construction phase of the works. This is defined as the period from the commencement of works to the substantial completion of the works. The Contractor is generally responsible for ensuring that the provisions of this EMP are met, with the exception of certain planning or design issues, which are explicitly noted throughout the EMP as being the responsibility of the Developer or the Consultant.

The Contractor shall ensure that all persons who are to be employed or sub-contracted for the works shall be trained as to their individual responsibilities as set out in this EMP, including the following.

General Environmental Duty – whereby a person in the performance of their duties shall not do so in a manner which will cause, or is likely to cause, environmental harm unless the person takes all reasonable and practical measures to prevent or minimise the harm.

Duty to Notify Environmental Harm – whereby if a person in the performance of their duties becomes aware that serious or material environmental harm is caused or threatened then the person must contact the Contractor whereupon the Contractor must immediately notify the Developer and/or the NSW EPA.

Compliance with the EMP – whereby a person in the performance of their duties shall do so in a manner that ensures that the provisions of this EMP are complied with.

2.4 Non-Compliance with the EMP and Corrective Action Requirements

The Contractor shall assume responsibility for implementation of this EMP. Where the Contractor becomes aware of a site or operational condition that does not comply with stated performance indicator(s) of this EMP, there is a requirement for corrective action. A Corrective Action Request (CAR) form is to be completed and authorised in general compliance with the example CAR form provided in Appendix A of this EMP. The Contractor is also required to maintain a register of CARs, which shall demonstrate that appropriate actions have been completed within a suitable timeframe.

Any CAR registered in accordance with this EMP shall be provided to the Developer, any State or Commonwealth Government Department, any statutory authority or other person, consensually or as lawfully required.

In some instances, further investigation or monitoring may be required to establish whether the Contractor has failed to adequately implement the EMP, or has failed to comply with relevant legislation, guidelines and statutes. In these instances, an independent party such as the Consultant shall carry out the investigation or monitoring. If it is established that the cause for non-compliance with the stated performance indicator(s) has arisen from the Contractor's actions or omissions, then the costs of the monitoring shall be deducted from payments to the Contractor and paid to the Consultant, otherwise the costs of the monitoring shall be obtained from the Developer and paid to the Consultant.

2.5 Emergency Contact

Suitably qualified personnel shall be designated as the 24 hour contact to handle environmental emergencies. The contact number shall be given to all employees on site

Details of the site emergency procedures shall be recorded and clearly displayed at the site including:

- name and contact number (all hours) for emergency response personnel;
- response personnel responsibilities;
- contact details for emergency services;
- location of onsite information on hazardous materials, including Material Safety Data sheets and spill containment materials;
- steps to follow to minimise damage and control an environmental emergency; and
- instructions and contact details for notifying relevant government agencies, local councils and nearby residents.

2.6 Legislative and Policy Framework

The following legislation and policies will apply to implementation of environmental management measures under this EMP.

- *Environmental Planning and Assessment Act 1979*
- *Tweed Shire Council Development Control Plan No. 16*
- *Tweed Local Environment Plan 2000*
- *Threatened Species Conservation Act 1995*
- *State Environment Planning Policy – Koala Habitat Protection*
- *Fisheries Management Act 1994*
- *Rivers and Foreshores Improvement Act 1948*

The *Environmental Planning and Assessment Act 1979* (EPA Act) controls the planning and assessment of land development in New South Wales. The EPA Act encourages the "management, development and conservation of natural and artificial resources" while promoting the "orderly and economic use and development of land".

The *Tweed Local Environment Plan 2000* has been prepared in accordance with the EPA Act and provides a legal basis for preparation of development control plans which contain provisions for land development within the Shire. The *Tweed Shire Council Development Control Plan No. 16 Subdivision Manual* (DCP16). DCP16 outlines Council's objectives for land development and provides guidelines and development standards for new subdivisions.

This EMP was developed in accordance with the provisions of the Tweed Local Environment Plan 2000 and DCP16. The development responds to the natural landform and drainage system and prevents significant alteration of existing site characteristics in accordance with the requirements of DCP16.

Site investigations were undertaken to determine opportunities and constraints of development. A Constraints Plan has been prepared to identify site features that require specific management under this EMP and other technical reports referred to herein. The Constraints Plan is presented as Figure 3.

An ecological assessment was undertaken to identify significant flora and fauna communities pursuant to the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994*, *Rivers and Foreshores Improvement Act 1948* and the *State Environment Planning Policy – Koala Habitat Protection*. The Ecological Assessment Report provides a description of the significant species and communities that require management. Protection of significant flora and fauna will be provided by management measures proposed within this EMP.

A Bushfire Management Plan has been prepared to address the threat of bushfire and to propose site management measures to prevent loss of life and property. The BMP has been prepared in accordance with the *Rural Fires Act 1997* and details site-specific requirements for provision of buffer zones and asset protection. Management of bushfire at the site will be undertaken in accordance with the BMP and is therefore not addressed within this EMP.

3. ELEMENT 1: CONSTRUCTION SITE WORKS PLAN

RATIONALE

It is the Contractor's responsibility to determine how the works will be conducted in compliance with this EMP and this determination is to be reported to the Developer.

OBJECTIVE / TARGET

To prepare a Site Works Plan that complies with all elements and requirements of this EMP.

TASKS / ACTIONS

The Contractor shall prepare a draft Site Works Plan prior to conducting any activities associated with the physical construction of the proposed development.

The draft Site Works Plan is to contain the following elements:

1. Flora and Fauna Management
2. Water Quality Management
3. Sediment and Erosion Control
4. Bushfire Management
5. Air Quality
6. Noise Emissions
7. Waste Minimisation
8. Contingency Plan

The draft Site Works Plan is to be provided to the Developer and if required, the NSW EPA. The Contractor is to have due regard for comments made by the Developer, NSW EPA and/or the Consultant prior to the preparation of the final Site Works Plan.

Provision of a final Site Works Plan by the Contractor for the approval of the Developer. The Developer is to issue its approval of the Contractor's draft Site Works Plan to the Contractor prior to the Contractor conducting any works.

PERFORMANCE INDICATORS

Compliance with all elements of this EMP.

All CARs are to be actioned within time frames agreed between the Principal and the Contractor.

All CARs raised in response to actual or potential environmental harm to be actioned within a maximum of 24 hours.

REPORTING AND REVIEW

Reporting to the Developer upon requirement to complete a CAR and the actions taken in respect of the CAR.

CORRECTIVE ACTION

Non-conformance with the Site Works Plan shall be documented and a corrective action request (CAR) issued. All CARs shall be included in the CAR Register to be kept under the provisions of this EMP.

The Contractor shall implement the corrective action as required within the agreed time frame noted on the CAR.

4. ELEMENT 2: FLORA AND FAUNA

RATIONALE

Construction of the proposed development has the potential to impact on areas of vegetation designated for retention public. Some of these areas have significant environmental value and must not be disturbed.

OBJECTIVE / TARGET

To ensure the protection of areas of vegetation designated for retention and to minimise the requirement for the removal of vegetation at the site.

To ensure that vegetation identified for retention is not removed or damaged during the works.

To manage development works in accordance with the *Ecological Assessment* to ensure that the requirements of the relevant State and Commonwealth Legislation are complied with.

TASKS / ACTIONS

The Contractor is to address the issue of flora and fauna management in the Site Works Plan required under Element 1 of this EMP.

The Contractor is to ensure that all management strategies detailed in the Site Works Plan are complied with at all times during the conduct of the works.

The Contractor is to ensure that areas of vegetation designated for retention are adequately fenced or protected to prevent disturbance or damage during construction works.

Prior to the commencement of any vegetation clearance, the Contractor shall identify all areas to be cleared on construction plans and in the field.

The Contractor shall mulch foliage and branches of cleared native vegetation for re-use on site. Trunks of native trees may be stored intact for re-use as timber.

The Contractor shall provide fences and/or trunk girdles to prevent unintended physical damage to the root system, trunk or canopy of native vegetation identified for retention in areas adjacent to any proposed works.

The Contractor shall remove cleared non-native vegetation from the site for disposal at a suitable facility such as a landfill. Non-native vegetation shall not be mulched for re-use on site, to minimise the risk of propagation.

The Contractor shall ensure all trees and vegetation identified for clearances are inspected for native animals, by a wildlife spotter-catcher, prior to clearance.

The Contractor shall ensure any vegetation containing native fauna is retained until the fauna either moves, or is removed and subsequently released at an appropriate location in good health.

The Contractor shall report any observations of sick or injured native animals within or adjacent to the work area to the spotter/catcher who will contact the relevant authorities to receive advice concerning specific measures to be taken.

PERFORMANCE INDICATORS

No removal of vegetation identified for retention.

No mortality to fauna species at the site during the works.

All CARs are to be actioned within time frames agreed between the Principal and the Contractor.

All CARs raised in response to actual or imminent potential environmental harm to be actioned within a maximum of 24 hours.

REPORTING AND REVIEW

Reporting to the Developer upon requirement to complete a CAR and the actions taken in respect of the CAR.

CORRECTIVE ACTION

Should there be non-compliance with the stated performance indicator the following corrective actions are to be implemented.

- Identification of the cause of the non-compliance;
- Implementation of appropriate mitigation measures as determined by the Developer and Consultant in consultation with the Contractor; and
- Relevant validation monitoring to confirm that the nominated corrective actions have been effective.

The Contractor shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

5. ELEMENT 3: WATER QUALITY MANAGEMENT

RATIONALE

Construction of the proposed development will involve excavation of soils and the alteration of landform at the site. Stormwater coming in contact with this material has the potential to transport sediment and/or other contaminants to natural drainage lines and receiving waters adjacent to the site.

OBJECTIVE / TARGET

To ensure that the existing qualities of the receiving surface and ground waters in the locality of construction works are not adversely affected by activities associated with the works.

TASKS / ACTIONS

The Contractor is to address the issue of water quality in its Site Works Plan required under Element 1 of this EMP.

The Contractor is to ensure that all management strategies detailed in the Site Works Plan are complied with at all times during the conduct of the works.

The Contractor shall provide temporary control measures as required during the course of the works to prevent soil erosion, scouring, sediment transport and deposition. Suitable measures are specified in the Soil Erosion and Sediment Control Guidelines, Institute of Engineers Australia.

The Contractor shall provide measures to divert clean stormwater runoff from disturbed areas of the site to ensure that clean stormwater runoff does not become contaminated.

The Contractor shall cover stockpiles and install temporary sediment control devices on downhill slopes.

The Contractor shall establish a site access point with shakedown and wheel wash to prevent soil-tracking onto external roads.

PERFORMANCE INDICATORS

The development shall ensure that any waters being discharged from the works site comply with the following quality characteristics or demonstrate that there is no worsening of existing conditions as determined by baseline water quality monitoring.

Water Quality Parameter	Release Criteria
Suspended Solids*	<50 mg/L
pH	4.0 to 7.0
Dissolved Oxygen	> 6mg/L
Hydrocarbons	No visible sheen
Litter	No visible litter
Total Nitrogen	0.3 mg/L
Total Phosphorous	0.03 mg/L

*Suspended solids testing (and limit) may be replaced with turbidity testing (and limit) only after a statistically significant correlation or r2 or >0.8 is demonstrated.

All CARs are to be actioned within time frames agreed between the Principal and the Contractor.

All CARs raised in response to actual or imminent potential environmental harm to be actioned within a maximum of 24 hours.

MONITORING

Water quality and control structures monitoring shall be undertaken in accordance with the following schedule.

Location	Frequency	Type	Parameter
Site discharge points	Monthly and during rain events of > 25mm / 24 hours	Laboratory analysis	pH Suspended Solids Dissolved Oxygen Total Nitrogen Total Phosphorous
All control structures	Daily	Visual inspection	Inspection of structures to ensure measures are in place and
Temporary sedimentation basins	Weekly	Visual inspection	Algal blooms Signs of erosion Sediment accumulation at discharge points

Water quality monitoring of groundwater shall be undertaken in accordance with the following schedule.

Location	Frequency	Type	Tests
Site Monitoring Bores	Monthly	Field Measurement	Water Level Conductivity / Temp. pH
Site Monitoring Bores	Quarterly	Laboratory analysis	Total Nitrogen Total Phosphorus Suspended Solids

RECORD KEEPING

The Contractor shall maintain a record of any monitoring results undertaken including details of corrective actions and/or repairs undertaken.

The Contractor shall make all records available for inspection by relevant authorities.

REPORTING AND REVIEW

Results of monitoring shall be forwarded periodically to a suitable qualified environmental consultant to ensure that water quality within the groundwater basin does not deteriorate due to construction activities.

CORRECTIVE ACTION

Should there be non-compliance with the stated performance indicator the following corrective actions are to be implemented.

- Identification of the cause of the non-compliance;
- Implementation of appropriate mitigation measures as determined by the Developer and Consultant in consultation with the Contractor; and
- Relevant validation monitoring to confirm that the nominated corrective actions have been effective.

The Contractor shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

6. ELEMENT 4: EROSION AND SEDIMENTATION CONTROL

RATIONALE

Excavated areas and stockpiles are to be protected from erosion and at the competion of the works the ground surface is to be rendered stable to ensure erosion and sedimentation of receiving waters does not occur as a result of the works.

OBJECTIVE / TARGET

To minimise the risk of soil erosion and sedimentation of the receiving waters at / adjacent to the site.

To manage development works in accordance with the *Earthworks Management Plan* to ensure that the requirements of the *Development and Design Specification D7 – Stormwater Quality and its Annexure A – Code of Practice for Soil and Water Management on Construction Works* are complied with.

TASKS / ACTIONS

The Contractor is to address the issue of erosion and sedimentation control in its Site Works Plan required under Element 1 of this EMP.

The Contractor is to ensure that all management strategies detailed in the Site Works Plan are complied with at all times during the conduct of the works.

Measures shall be implemented in accordance with the requirements of the Soil Erosion and Sediment Control Guidelines, Institute of Engineers Australia. Such measures may include, but should not be limited to the following.

1. The use of sediment fences around the downslope boundary of all areas of disturbance over the site prior to commencement of construction works.
2. The use of sediment retention basins where significant areas of bare earth are exposed.
3. The use of a designated site office area with a gravel pad base for vehicles entering and leaving the works site.
4. The use of stormwater diversion and transportation infrastructure around the upslope boundary of all disturbance areas to divert clean stormwater around the site.

The Contractor shall check and repair the erosion and sediment control devices in use over the site daily and immediately following rain events >25mm/24 hours.

PERFORMANCE INDICATORS

Sediment concentrations in water discharged from the site in accordance with water quality criteria stated in Element 3.

All CARs are to be actioned within time frames agreed between the Principal and the Contractor.

All CARs raised in response to actual or imminent potential environmental harm to be actioned within a maximum of 24 hours.

MONITORING

Daily inspection of all erosion and sedimentation control devices shall be undertaken to validate optimum performance. Devices shall be inspected immediately following rain events >25mm/24 hours.

RECORD KEEPING

The Contractor shall maintain a record of any monitoring results undertaken including details of corrective actions and/or repairs undertaken.

The Contractor shall make all records available for inspection by relevant authorities on request.

REPORTING AND REVIEW

Reporting to the Developer upon requirement to complete a CAR and the actions taken in respect of the CAR.

CORRECTIVE ACTION

Should there be non-compliance with the stated performance indicator the following corrective actions are to be implemented.

- Identification of the cause of the non-compliance;
- Implementation of appropriate mitigation measures as determined by the Developer and Consultant in consultation with the Contractor; and
- Relevant validation monitoring to confirm that the nominated corrective actions have been effective.

The Contractor shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

7. ELEMENT 5: AIR QUALITY

RATIONALE

Construction of the proposed development will involve the use of powered mechanical equipment for movement of earth material to achieve the required landform for the proposed development. The bulk handling of this material has the potential to create air impurity emissions by release of dust as suspended then deposited particulate matter.

OBJECTIVE / TARGET

To minimise the emission of air impurities associated with construction works.

To comply with the stated performance indicators for air impurity levels in the locality of the works.

The Contractor is to address the issue of noise emission in its Site Works Plan required under Element 1 of this EMP.

The Contractor is to ensure that all management strategies detailed in the Site Works Plan are complied with at all times during the conduct of the works.

Activities resulting in the introduction of dust and fumes to the local atmosphere shall be minimised as far as practicable during construction. Such activities may include the manual or mechanical handling of stockpiles of building materials or the use of air emission generation vehicles.

Earthworks shall be managed to control dust. Specific control measures may include, but may not be limited to the following.

- Completion of vegetation clearing in stages, in order to minimise the area of open ground exposed at any one time.
- Early stabilisation and revegetation of any cut or filled areas and slope works using, for example, wood chip layers.
- Watering of all exposed areas as required.
- Provision of windbreaks and silt fences as required.

Stockpiles shall be managed to control dust. Specific control measures may include, but may not be limited to the following.

- Minimisation and stabilisation of stockpile areas.
- Maintenance of stockpiles within designated areas and prevention of spread of stockpile material into adjacent areas.
- Creation of no more stockpiles than is necessary, and removal of all stockpiles upon completion of works at the site.
- Provision of windbreaks and silt fences as required.

The emission of air impurities associated with operation activities shall be minimised to ensure compliance with the specified performance criteria.

All vehicles and equipment shall be operated and maintained in accordance with the manufacturer's specifications.

PERFORMANCE INDICATORS

No complaint relating to excessive emission of air impurities from the works site from any person.

Air quality criteria for limits on odour and particulate concentrations are presented below.

Parameter	Maximum Acceptable Concentration
Annual 24 hour averaged dust concentration, total suspended particulates	90 µg/m^3
Annual 24 hour averaged dust concentration as PM_{10}	50µg/m^3
24 hour average dust concentration as PM_{10}	150µg/m^3
Visibility	20km
Average dust deposition rate	120mg/m^2/day

MONITORING

If through the CAR process it is determined that on the balance of probabilities the Contractor's actions have brought about a complaint then monitoring of suspended particulate matter at the complainants premises is required.

RECORD KEEPING

The Contractor shall maintain a record of all complaints received in relation to air quality including complainant details, nature of complaint and corrective actions undertaken.

The Contractor shall maintain a record of any monitoring results undertaken including details of corrective actions and/or repairs undertaken.

The Contractor shall make all records available for inspection by relevant authorities on request.

REPORTING AND REVIEW

Reporting to the Developer upon requirement to complete a CAR and the actions taken in respect of the CAR.

CORRECTIVE ACTION

Should a complaint relating to excessive emission of air impurities from the works site be received the following corrective actions are to be implemented.

- Response to complainant outlining procedure for corrective action
- Identification of the source(s) of the excessive emission of air impurities;
- Implementation of appropriate mitigation measures as determined by the Developer and Consultant in consultation with the Contractor; and
- Relevant validation monitoring of air impurity concentrations at nominated locations.
- Notification of complainant that complaint has been closed out, with details of corrective actions undertaken.

The Contractor shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

8. ELEMENT 6: NOISE EMISSION

RATIONALE

Construction of the proposed development will involve the use of powered mechanical equipment. Appropriate management measures are required to ensure that noise produced at the site during construction works does not result in annoyance or disturbance at the closest noise sensitive place.

OBJECTIVE / TARGET

To control noise generated by construction activities and to minimise the impact of noise to ensure acceptable levels of amenity for the closest sensitive receptors.

TASKS / ACTIONS

The Contractor is to address the issue of noise emission in its Site Works Plan required under Element 1 of this EMP.

The Contractor is to ensure that all management strategies detailed in the final Site Works Plan are complied with at all times during the conduct of the works.

All noise generating mobile and stationary plant and equipment, and processes shall be controlled to minimise noise emission in accordance with AS 2436: Guide to Noise Control on Construction, Maintenance and Demolition Sites. In particular, all powered mechanical equipment shall be fitted with effective exhaust mufflers.

Noisy activities shall be avoided at times that are likely to cause disturbance at neighbouring locations.

Working hours at the site shall be limited to the period between 7.00am and 6.00pm Monday to Friday and 7.00am to 4pm Saturday. There are to be no works conducted at the site on Sunday or during public holidays.

All vehicles entering or leaving the site or used at the site shall be operated and maintained in a manner which ensures that the noise levels produced by the vehicles are within the limits of the Commonwealth Department of Transport and Regional Services Federal Office of Road Safety Australian Design Rule ADR28- External Noise of Motor Vehicles.

In the event of the adjusted noise level for a single noise source or activity, exceeding the background noise level by more than 10 dB(A) at any noise sensitive location, consideration shall be given to restricting the times during which the activity can take place to a number of separate hours each day. Persons affected by the noise shall be consulted with regard to suitable hours and advised of the agreed operations schedule.

PERFORMANCE INDICATORS

The works shall be carried out by such practicable means necessary to prevent the emission of noise that constitutes *"unreasonable"* or *"intrusive"* noise.

MONITORING

Monitoring shall be undertaken as required by regulatory authorities following receipt of complaints relating to excessive noise.

RECORD KEEPING

The Contractor shall maintain a record of any monitoring results undertaken including details of corrective actions and/or repairs undertaken.

The Contractor shall make all records available for inspection by relevant authorities on request.

REPORTING AND REVIEW

Reporting to the Developer upon requirement to complete a CAR and the actions taken in respect of the CAR.

CORRECTIVE ACTION

Should a complaint relating to excessive emission of noise from the works site be received the following corrective actions are to be implemented.

- Response to complainant outlining procedure for corrective action
- Identification of the source(s) of the excessive emission of noise;
- Implementation of appropriate mitigation measures as determined by the Developer and Consultant in consultation with the Contractor; and
- Relevant validation monitoring of noise levels as a result of the works at nominated locations.
- Notification of complainant that complaint has been closed out, with details of corrective actions undertaken.

The Contractor shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

9. ELEMENT 7: WASTE MANAGEMENT

RATIONALE

Waste management at the works site is to focus on appropriate methods to avoid, reuse, recycle and dispose of waste materials generated as a result of the works.

OBJECTIVE / TARGET

To ensure that all materials used to conduct the works do not cause unlawful environmental harm.

To ensure that no waste material is released from the site in an uncontrolled manner.

TASKS / ACTIONS

The Contractor is to address the issue of waste management in the Site Works Plan required under Element 1 of this EMP.

The Contractor is to ensure that all management strategies detailed in the Site Works Plan are complied with at all times during the conduct of the works.

Construction Contractors shall maintain a regular waste removal schedule and document all waste disposal activities. These activities shall be listed on a Waste Register Form, an example of which is provided in Appendix B.

The Contractor shall provide appropriate methods for the collection and lawful disposal of any wastes produced at the site during the works.

The Contractor shall provide separate on-site storage bins for reuse of waste materials. Waste materials that cannot be reused on site shall be separated into designated holding containers for collection.

The Contractor shall provide separate waste holding bins and recycling bins within construction working spaces.

The Contractor shall colour code all waste holding bins for separation of wastes into categories.

The Contractor shall provide adequate signage for all waste holding and disposal bins. The Contractor shall locate waste disposal skip(s) in a designated area(s) suitable for collection by waste disposal vehicles.

The Contractor shall have due regard for the waste management hierarchy The waste management hierarchy lists the types of waste management practices in preferred order of adoption, as detailed below.

1. Waste avoidance
2. Waste re-use
3. Waste recycling
4. Energy recovery from waste
5. Waste disposal

PERFORMANCE INDICATORS

No waste of any type to be released from the works site in an uncontrolled manner.

Visual inspection of on-site waste holding and waste collection areas shall be undertaken routinely. Evidence of waste spillage or dispersal shall indicate non-compliance with the objectives and the tasks/actions outlined in this WMP.

Visual inspection of on-site stormwater drains shall be undertaken routinely in accordance with the schedule presented in Element 3. Evidence of stormwater blockage by wastes or pollution shall indicate non-compliance with the objectives and the tasks/actions outlined in this EMP.

FREQUENCY / DEADLINE

Waste shall be collected for disposal on a regular (at least weekly) basis, and additional services shall be arranged if required. The collection site shall be inspected weekly by the Contractor during construction and by the Operator during operation to determine the need for additional collection services.

Visual inspections of all waste holding and collection areas and stormwater drains shall be undertaken by the Contractor on a daily basis during construction.

MONITORING

Periodic site inspections shall include monitoring of waste accumulation within the site to ensure timely removal from site.

The Contractor shall maintain a record of all complaints received in relation to waste including complainant details, nature of complaint and corrective actions undertaken.

RECORD KEEPING

Records of all waste management actions shall be maintained including details of regulated waste tracking, removal by contractors and proposed disposal.

The Contractor shall make all records available for inspection by relevant authorities on request.

REPORTING AND REVIEW

Reporting to the Developer upon requirement to complete a CAR and the actions taken in respect of the CAR.